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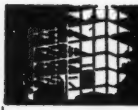

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A WAILING WALL IS NOT A BUILDING WALL

W. L. EVERITT

President, ASEE, 1956–1957
Dean, College of Engineering,
University of Illinois, Urbana

At the Geneva Conference, great attention was given to an analysis of the energy resources of the world and the rate at which they are being depleted. If one considers only the present rate of utilization of fossil fuels and also takes into account the rate at which new sources are being discovered, one can predict that the present supplies would last, at the most, for six hundred years. However, if we also take into account predictions of future utilization based upon the present rate at which energy consumption is *increasing*, this future is reduced immediately to an estimate of only some 200 years.

Furthermore, if our efforts to increase the standard of living throughout the world to one approximating that of the United States are successful, we could easily deplete our fossil fuels in a matter of a hundred years. It is evident, therefore, that it is not only desirable, but absolutely essential, that new sources of energy be developed.

At the moment the most promising new source of energy appears to be nuclear fission. However, resources of uranium and thorium are also finite. The world supply of uranium might last for a matter of six hundred years and then it, too, would be depleted. If scientists and engineers are able to develop the control of fusion, however, then the source of fuel can be ocean-supplied heavy hydrogen, of which there is an unlimited quantity. This, then, appears to be one of the major challenges to science and engineering—the development of new resources of energy.

The Engineer's Function

The task of the engineer can be roughly divided into three major areas —the processing of energy, the processing of materials, and the processing of information. Even more challenging than the problem of limited energy resources is that involving limited supplies of materials.

It appears that the amount of iron ore available is finite and may well be exhausted before our fossil fuels. However, while fossil fuels, because of their historical development from flora and fauna, are necessarily limited to the thin outer layer of the earth's surface, there are indications that iron may be a major constituent of our planet's inner core. Hence, there is at least some hope that deep mining methods could provide us with unlimited resources in materials.

Nevertheless, the development of materials is a second great challenge to the engineer. Furthermore, new materials are important not only as replacements for existing ones but often provide new possibilities for design. Consider the limitations on the development of modern aircraft if aluminum had not been made both plentiful and relatively cheap.

"Information," in the sense used by the communications engineer, appears to be unlimited, but its proper proc-

essing is of great interest. Information is generated both by human beings and by machines, and may be utilized, in turn, either by human beings or machines. It can be stored in printed books, on punch cards, or on magnetic tapes. Like entropy, in terms of which it can be specified, it is always increasing.

Functions of the Engineering Teacher

Since engineering teaching is certainly a branch of the engineering profession, a fourth processing function should currently be added to the trinity I have just mentioned. This is the *processing of intelligence*. The intelligence to which I am referring is indigenous to man, even though someone has said that machines are becoming so like people that they can act without using any intelligence.

It is apparent that the supply of intelligence is finite. It is in short supply even today, and there is every indication that its scarcity relative to the world's needs will increase continuously. Therefore, it is of the utmost importance that the processing of this limited supply of intelligence should be given first priority among engineering problems.

Particularly in the military field, but generally in all fields, the fate of our civilization and of ourselves as individuals depends upon the optimum utilization of our potential skills and insights, and upon our successful application of technical imaginations to the problems of power and scientific advance.

Spengler has made the point that the master-races of the past have decayed and been overcome for lack of attention to continued technological progress. So the Roman empire might well have extended its peaceful reign if its civil and military engineers had been able to develop guns or projectiles to keep out the personally stronger and more numerous invading tribes to the North. Spengler argues that this has been particularly so in the arms and weapon-systems areas, but it would now seem to apply also in the power resources and productivity fields as well.

Our Hopes and Needs

The hope of the free world is to develop peaceful sources and uses of energy, and to perfect a world-wide social organization which will enable the whole earth to live in harmony. This seems to imply an immediate need to maintain such technological strength as we now have, and to increase it wherever possible through further progress, both military and productive. Only in this way can we guarantee the continuance of peace and the availability of adequate energy supplies to support our increasing world populations.

It has been pointed out that resources of energy from fission appear to be much more limited than resources from fusion. An analogy might will be drawn in the matter of our intelligence resources. In the past, major intellectual advances came from what might be called fusion, from the spontaneous generation of brillant ideas by men of genius, men like Confucius, Socrates, Plato, Aristotle, the early Christian leaders, Thomas Aquinas, Chaucer, Leonardo da Vinci, Copernicus, Galileo, Shakespeare, Newton, Goethe, Benjamin Franklin, Thomas Jefferson, Edison, Maxwell, Eddington, Jeans, Einstein, and Gandhi, to mention only a few. The majority of these great minds were self-trained. There was appar-

ently no organized method for generating intellectual energy such as they displayed. They appeared spontaneously and haphazardly, a few per century, or even less.

Only a little over a hundred years ago, however, the universities, which for centuries had served primarily as tape recorders for the preservation and playback of classical information, began to develop, particularly through professional colleges such as engineering, a new and rapidly expanding resource for the generation of ideas. While these institutions of higher education, with new emphasis on the physical sciences and applied mathematics, have not produced any appreciable increase in the numbers of individuals with the mark of genius (it is doubtful if they ever will), universities and technical colleges *have* produced new sources of intellectual vigor analogous to the hoped-for supply of energy from controlled fusion.

Through a system of education admittedly open to criticism, the engineering college has developed individuals who by participating in team operations have been able to direct the remarkable progress which has resulted in our modern industrial civilization. Making use of the principle of *idea-fusion*, such teams have shortened markedly the time-lag between scientific discovery and practical utilization or public acceptance.

This reduction is perhaps the most striking development of our present century. For example, the original scientific concept of steam power was due to Hero of Alexandria in 75 B.C., yet it was almost 1800 years later before Newcomen developed a steam engine, and another 60 years before Watt added automation so that the engine could go about its work without constant attendance.

In the nineteenth century, it was 40 years from the studies of Faraday and Henry on electromagnetic induction until Graham and Edison developed electrical power. It was nearly 40 years from the pioneer analytical work of Maxwell in 1862 until Marconi developed a radio capable of covering distances which made it a practical form of communication.

At the turn of the century, it was 20 years from the time Edison discovered the electron-flow effect from a filament to a cold plate in an electric lamp (Edison in this discovery being the scientist) until Fleming and De-Forest produced practical and useful vacuum tubes. Contrast this with the relatively short time from the discovery of nuclear fission by Meitner, Hahn, and Strassman in 1939 until the first controlled atomic reaction was developed by Fermi in 1942, and the atomic bomb was completed by a large team of engineers and scientists as early as 1945.

Even more remarkable was the development of the transistor. The discovery of the fundamental nature of the flow of holes and electrons in semiconductors was followed in a matter of only a few weeks with the invention of the transistor by the same team of Bardeen, Brattain, and Shockley who had done the fundamental scientific work. These were men trained as both engineers and scientists in our modern universities.

Our Future Resources of Intelligence

If, then, the keys to our technological future depend upon the development of intelligence in the form in which it can function as scientific

teams, it appears evident that the forging of these keys depends primarily upon the proper functioning of the members of the teaching profession.

We hear a great deal about the shortage of engineers. More people must realize that the solution of this problem is retarded not so much by the supply of students as by the critical shortage of engineering teachers. For that reason, the American Society for Engineering Education is taking as its present and next major task a study of the recruitment, development, and utilization of engineering faculties. A Committee on the Development of Engineering Faculties (a truly alphabetical group, CDEF!) has been set up with Professor Harold Hazen of MIT as its chairman.

The Committee has been hard at work during the past few months developing an intensive planning program, and getting financial support. The National Science Foundation gave the Society a grant of $10,000 for the planning phase, and we have secured Dr. William H. Miernyk, Director of the Bureau of Business and Economic Research of Northeastern University, as Executive Director. Other members of the Committee are Joseph C. Boyce of IIT, Dean Gordon B. Carson of Ohio State, Morris D. Hooven, President of ECPD, and William C. White, Vice-President of Northeastern University.

The Committee has divided its work into four phases:

1. The determination and effective documentation of the need in both qualitative and quantitative terms.

2. The definition and description of the problems that must be solved to satisfy this need.

3. Exploration of methods to recruit an adequate supply of engineering teachers.

4. Determination of appropriate means for promoting growth and development of teachers and providing for their most effective utilization.

The Committee has the support of, and is effectively collaborating with, the Engineers' Council for Professional Development, the Engineers' Joint Council, and the National Committee for the Development of Scientists and Engineers appointed by President Eisenhower (now the President's Committee on Scientists and Engineers).

Through Seed Shall Ye Reap

It was well recognized by the pioneers of this nation, who depended upon an agricultural economy, that a portion of each year's crop must be saved as seed for the following year, or an entire community would face starvation. Unless our modern industrial community dedicates an adequate portion of the intellectual crop of our universities as the seed for recurring harvests, we will be overwhelmed.

Furthermore, in an agricultural economy, it is generally recognized that the portion of the crop saved for seed should be the best and most vital; it should also be most carefully nurtured and kept. The total amount is not large. Three to five per cent of engineers devoted to engineering teaching seems adequate, but this percentage is in grave danger of being reduced rather than maintained.

Though in the abstract our problem is being recognized more and more by industry and government, I think it is the *engineering teacher* himself who must be primarily responsible for calling attention to the essential character

of the engineering teacher as the seed which produces the crop of the future.

While I am drawing a number of analogies, I will run the risk of mixing my metaphors to call your attention to another historical phenomenon. Most of you are familiar with the wailing wall in Jerusalem. This wall is a remnant of the temple which was destroyed by Titus in 70 A.D. At this wall the Jews were wont for many years to go and weep about their own miseries and the vanished glories of Israel. It is doubtful, however, if those who expended their energy in wailing contributed much to the build- of the new Israel.

It is my firm belief that the engineering teaching profession has engaged too much in loud public lamentation. Teachers have seemed to take a self-torturing delight in presenting themselves as downtrodden, underpaid, and underprivileged.

This may, and perhaps has, developed in the minds of the public a feeling that we are, indeed, inferior or at least odd. Make no mistake, people will take us for what we say we are, especially if we place a low estimate on ourselves.

While this wailing may at times be justified, I feel that it has seriously reduced the prestige and status of our profession. Dead martyrs are revered, but live martyrs are avoided, especially self-designated ones. It is possible that as a result of our wailing some people may feel sorry for us, but they are not likely, under these circumstances, to try to understand our problems or take effective steps to reduce our martyrdom.

The net result is that we have not presented to our students or to the public an attractive picture of the teaching profession, and we are therefore finding it more and more difficult to convince anyone that ours is indeed a profession which the best minds should seek to enter. Many people interpret our devotion to teaching as the attraction of a soft life and a desire for security, and so ask why should they do anything for us. This depreciation and continual moaning discourages recruits.

I well remember one time when I was in charge of a sophomore survey course. I had a number of the faculty give talks so that the students would become acquainted with the staff of the department. At the end of the semester, in accordance with custom, I gave an examination. Among other questions, I asked the students to comment on the course. I still remember the answer of one who said, "If these professors are as good as they make out to be, why don't they get out and get real jobs?"

Now, I do not believe that we who are teachers are morons or even slightly "touched" in the head. We are teaching because we feel it is the most exciting career possible, the most rewarding activity open to the engineering profession. To us the attractions of teaching are superior to the sum of the attractions offered by all positions in industry and government. Are we doing everything we can to get these attractions across to our better students so that they will join us as faculty reinforcements? If we do not do this, we will surely be overwhelmed by the flood of prospective students which is already upon us.

While salary deficiencies are serious and those of us who are administrators must work on this a good proportion of the time, I do not think we should make salaries the continual center of discussion. As a matter of

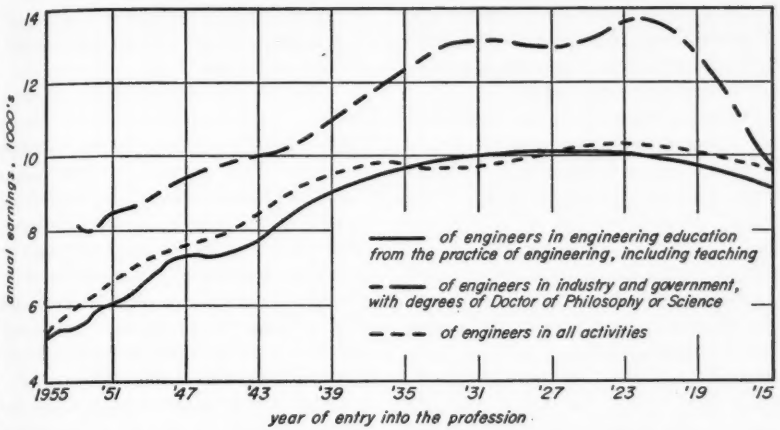

FIGURE 1. *Composite graph made up of the three median curves of total annual income based on data from Report #102, "Professional Income of Engineers, 1956" of Engineers Joint Council.*

fact, when one examines the curves of last year's survey by the Engineers' Joint Council, as shown in Figure 1, and considers the median of the total incomes of faculty members compared with those for the profession in general, it is surprising how close together these curves lie.

Of course, we demand that teachers be drawn from the superior group of our graduates, so I will admit that if one takes financial reward as the primary criterion, teachers should be better paid than average engineers. However, the difference is not so significant that we should be frightening young people *away* from teaching. The curves also show the advantages of graduate training. We might use such data both to encourage ourselves and to attract more students into advanced study, research, and teaching.

Our Mission

We should accent the positive, definitely. Do we have a real sense of mission? We should, and I believe most of us actually do.

A major attraction of the teaching profession is that it allows us to work with the trinity of people—ideas—things. I think Engineering teaching is primarily attractive to people who like to work broadly with all three. Furthermore, if one likes to work with *young* people, one obtains a real thrill from seeing them develop, go out into the world, and produce. Through this means we multiply our own efforts in a way which cannot be equalled by any other endeavor.

Another great attraction of teaching is that we are our own bosses. No one is so free to plan his own work as an engineering professor. When I say no one, I do not except entrepreneurs who run their own businesses. I certainly do not except administrators, including deans, whose duties are largely determined by the problems which others bring to them.

The final important attraction of

teaching is the unexcelled opportunity for interchange of ideas with the other highly creative and interesting people in an academic community.

Our own attitude toward teaching will affect greatly the way we teach. Someone has said that there are three major ways to teach. One has been called "Forced-feeding—I know you hate it, but it is good for you." The second might be called "Spoon-feeding—Just remember what I told you." The third and best way is an "Invitation to learning—This is fine, let's share it." Only the instructor who really believes in the mission of the teacher can properly develop the last and most effective method to the ultimate degree.

By your works shall you be known. A new minister came into a town and a merchant, asked what kind of a man the pastor was, replied, "He's the best minister they have ever had." The questioner said, "Oh, then you have heard him preach." "No," was the comment, "but he must be good, because since he came to town his parishioners have been paying their bills."

The Road Ahead

We have many problems before us which we must solve. It is a major characteristic of an engineer that he does not do repetitive tasks. He must either be designing new products or developing improved methods for producing old ones. A question which can be asked very seriously is whether we as engineering teachers have shown fully enough this characteristic of the engineer. Too often we insist upon doing things in the same old way. I doubt if this is going to be good enough to meet the problems of the next decade when we expect twice as many students as we have at present. One thing seems certain, we will have to use more younger, less experienced teachers.

One of the most serious problems in the recruitment of teachers is the differential in salary for the younger men. When I started teaching, a graduate could be an instructor and work for a degree at approximately the same salary as was available to him in industry. One realized his lifetime income would be less in academic life, but it is always easier to plan a sacrifice in the future than to contract for one immediately.

Today our engineering colleges, perhaps in cooperation with industry, may need to develop better plans for the initiation of young men into the teaching profession than the present system of half-time assistantships or fellowships. Most such appointments do not provide adequate incomes for modern living. This is why the EJC curves for teachers show the greatest deviations in the early years.

An example of a new plan which we are developing at Illinois results from a proposal of E. C. Jordan, Head of our Electrical Engineering Department. Under this plan, after a student has obtained a Master's degree, an instructorship on two-thirds time may be supplemented by a concurrent appointment to an industry-sponsored fellowship which pays the remaining one-third of an instructor's salary. In this way, a full-time salary can be paid, while the individual progresses at a reasonable rate toward his Ph.D. degree.

An ideal combination for an engineer after receiving the B.S. degree might be one year on a fellowship while taking full-time work toward the M.S., two years on a combination teaching-industrial fellowship of the

type proposed, and, after completion of the preliminary examination, two years on an adequately salaried research assignment which could be coordinated with the thesis program. Men receiving the Ph.D. degree under this program will have had experience with full-time study, teaching with a moderate load, and full-time research. It could be expected that a significant portion of the students so exposed would develop an enthusiasm (not an aversion as so often in the past) for the exciting life of a teacher—a man who not only can stimulate his students but at the same time can also engage in advancing knowledge.

It seems apparent that we will also have to find new ways of expanding the effectiveness of the individual teacher while, at the same time, retaining personal contact with our students. There has been a great deal of emphasis upon the importance of recitation in contrast to lecture. Yet I think we will all admit that too many of us insist upon smaller classes and then lecture to them after we have discussion-size groups.

If we are going to lecture, we should admit it and see what training aids we can use to improve our lecturing. Perhaps, at the same time, we can reach more students with a given effort. For example, TV in its present form may not seem suitable for engineering education, but how do we know unless we try? And when TV tape recorders are available in economical form, will the ability to record and edit lectures and demonstrations make this tool more attractive? We need to give every effort to increase our teaching efficiency, both qualitatively and quantitatively.

A Further Mission

There has also been a great deal of talk about the fact that the world does not understand engineers. Among engineers, the teachers should be the best communicators, the most vocal. In addition to teaching our students, we should adopt a preaching mission to let the world at large know about engineering. We must make people understand that engineering is not primarily a way of making a living, but is a way of life, a *good* way of life. And, while we are at it, let them know that, among all the branches of the engineering profession, teaching is the most rewarding.

We can indeed build the walls which are the foundations of the future if we do not waste time weeping over our own fate. And if we build well, we will not only enjoy the best reward of all, the knowledge of a job well done, but will also be more likely to be recognized by our fellowmen with an adequate share in the good life of our nation to which we contribute so much. Your American Society for Engineering Education is planning to help, but we must all have a will to work and exercise our own ingenuity. Remember, a Wailing Wall can never be a Building Wall.

DO YOU KNOW . . . .

► . . . . That both the Engineering Manpower Commission and the Scientific Manpower Commission agree that the major problem in engineering and scientific manpower is no longer recruitment of students? They predict 44,000 engineering graduates in June of 1960—only three years away. While ASEE's CDEF (Committee on Development of Engineering Faculties) is making a penetrating study of the faculty problem, EMC will study the relationship between school capacity and enrollments. Just about everyone now is agreed educational quality and adequate facilities are the major problems.

► . . . . That the National Science Foundation has granted the Society $10,000 for the initial planning stages of the CDEF project? A progress report will be given at the Annual Meeting Tuesday morning General Session. Also, it is hoped a discussion can be printed in the September JOURNAL for those of you unable to go to the Cornell meeting.

► . . . . That about 700 new members joined the Society this year? The net gain in membership, however, is only about 300 because of resignations, deaths, and drops for non-payment of dues. Would a goal of 1000 new members for next year be unreasonable? At some institutions great progress was made this year, but at others practically nothing was done! Consequently there still is room for improvement.

► . . . . That about 55 per cent of the new members for the year were 36 years of age or under? Of the entire membership, almost exactly 50 per cent are 36 or under.

► . . . . That seventeen of the one hundred Science Faculty Fellowships awarded by the National Science Foundation went to engineers? Sixteen will be studying at twelve U. S. institutions; one will study abroad. Only one of the thirty Senior Postdoctoral Fellowships went to an engineer, and he is studying abroad. There were 416 applicants for the Science Faculty Fellowships and 168 for the Senior Postdoctoral fellowships, all of which carry stipends adjusted to approximate the regular salaries of the recipients.

► . . . . That last year the Engineering Foundation made research grants totalling $65,350? Twenty-eight research projects benefited by amounts ranging from $500 to $5000. Sizeable grants usually are made to assure sufficient progress on new projects for industry to become interested and assume the major portion of the costs. When that is achieved the Foundation support is reduced to an annual token grant of $1000.

► . . . . That ECRC is attempting to establish a closer relationship with the National Science Foundation in order to assist better distribution of information to colleges of engineering? It is believed by some that finding out about NSF programs is too haphazard and too prone to result in misunderstandings. Detailed plans have not been developed.

▶ . . . . That as you read President Everitt's article in this issue of the JOURNAL you should think back to C. C. Furnas' article of the May issue? Remember, the latter estimated that 1 billion 200 million dollars per year are needed to achieve an engineering educational goal of 60,000 B.S., 10,000 M.S., and 2000 Ph.D. degrees per year. Capital improvements and additions represent an additional 1 billion 230 million dollars. Perhaps you will also want to correlate the thoughts presented in these two articles with "Ivan Goes to School," by C. J. Lapp in the April JOURNAL.

▶ . . . . That there is an "Answer To Your Engineering Manpower Problems"? A new pamphlet prepared by the National Committee for the Development of Scientists and Engineers bears that name. The brochure is designed for industrial management and points out ways in which technicians can be used to release engineers and scientists for projects requiring professional training. Copies can be obtained from NCDSE, Washington 25, D. C.

▶ . . . . That Rudyard Kipling prepared the "ritual of the engineer" now used in Canada? As a result of a growing interest in ASME, EJC is appointing a committee "to study and report recommendations for implementing a program leading to the establishment of the Ritual of the Engineer." It is to be similar in nature but not in conflict with the Canadian version.

▶ . . . . That "The Story of Power" is a most interesting booklet for both adults and high school students? In simple terms and in fifty pages, the transition from muscle to wind, water, combustion, splitting of the atom, and utilizing the sun is traced. From another point of view, the story moves briskly and dynamically from the pyramids of Egypt to the pony express, the clipper ships, sail boats, windmills, water wheels, steam engines and turbines, the gasoline engine and its four-stroke cycle, diesel engines, the various types of jets and gas turbines, the free-piston engine, atomic power, nuclear reactors, $E = MC^2$, and the sun's heat. Each step is well illustrated. (Copies may be obtained without charge from the Public Relations Staff of General Motors at Detroit 2, Michigan.)

▶ . . . . That in this last item in the last DYK of the year I want to say many, many thanks to all who helped make this another big year for ASEE. I'll not mention names, for all contributions—large and small—are greatly appreciated. The Society has continued to grow in stature and influence. Some goals were achieved—at least you again began to receive the JOURNAL during the month printed on the cover! That was no easy task and much credit must go to the Editor, E. C. McClintock, Jr. But all problems are not yet solved. Next year we again will need all the help you can give, particularly for increasing the number of individual and associate institutional members. Thanks for this year's efforts—and a determination to do even better next year!

W. LEIGHTON COLLINS
Secretary

HAS SCIENCE FAILED OUR SCHOOLS?

JOHN F. OHLES

Director of Guidance, Crookston Public Schools Independent School District No. 1, Crookston, Minnesota

"A great deal has been said lately about the relationships between the public schools and science, particularly with reference to the number of engineers being graduated each year, and to the level of preparation for science and engineering displayed by our high school graduates. It seems to me that an even more important area should be studied, however: the lack of technological progress in our schools. It truly seems amazing that education has advanced so little in the use of scientific aids, especially when one considers the great influence technology has had on the rest of modern life."

Scientists and engineers have recently done a bang-up job of roasting American educators on the charge that schools are not preparing future science majors in sufficient quantity to secure America's future. Perhaps an even greater service could be performed if smoke were raised over the more important proposition that science has failed our schools!

Despite the current expressions of concern over preparatory education, science and technology have been far more active in bringing efficiency into office, shop, and kitchen than to the classroom. In this age of mechanical miracles, the school phenomenon seems to be a lack of progress in that very nest from which come fledgling scientists and technologists.

The reasons, excuses, and alibis for this void of scientific progress are many, varied, and often convincing: "When teachers tell us what they want, we'll do the job"; "It's educator conservatism that slows the wheels of progress"; "The engineer is detached from the school, from a familiarity with its needs"; "Schools need nothing from science, rather a willingness to do their particular job as well as it must be done."

There are many reasons for a lack of effort on the part of science to invade the classrooms. One compelling reason for such an interest, however, is the fact that without a healthy and productive school system, science will wither and die. By its own endeavors, science is daily placing a greater burden on educational institutions and is thus making ever more difficult the evolution of future scientists.

It is, indeed, a difficult transition from nuclear reactors, supersonic space travel, and research on the cause and cure of ancient medical mysteries to the level of "one plus two are three" and "C–A–T spells cat." Such a transfer of attention is demanded, however, for while tremendous strides are being made in the laboratory, classroom techniques remain technologically at the level of a century ago. The community schoolhouse is probably the only institution in society today that has progressed more rapidly in philosophy and human techniques than in the sphere of science and mechanics.

Persons alerted to recent experiments in education know the desperate schemes being evolved to reduce non-instructional burdens of the teacher. Suggestions have called for "teaching aides" who are to assume the essential trivia that plague blackboard technicians. This effort has been greeted with skepticism for a number of reasons, the additional expense placed on financially-stricken schools being by no means the least important one.

Education's invitation to the scientific gadgeteer includes both non-teaching and instructional duties. In the menial task department, an electronics engineer would have a field day. A button at each pupil's desk could simultaneously record attendance for both teacher and school office. Dirty, inefficient, hard-to-read blackboards await replacement by tidy and legible luminous boards.

Test correction could be a matter of seconds rather than hours if electronic answer boards for each child were scored at the touch of a lever from a teacher's master board. Even a simplified mechanical key marking correct responses of a standardized answer sheet with ink dots could save hours, fatigue, and eye-strain.

Those mechanical devices borrowed by schools that comprise the audio-visual program await utilization because of the inconvenience of moving classes to a special "movie room," of dividing use of a tape recorder or record player among twenty or thirty teachers. Paramount objection, of course, is the expense of providing each room with television and radio receivers; opaque, movie, slide and film strip projectors; record player and tape recorder. Even if money could be provided for these teaching tools, classrooms would not be large enough to accommodate them!

Should we believe that there is, as yet, no one with the skill to incorporate these useful teaching instruments into one inexpensive unit? Surely a television receiver might be the basic tool for all forms of picture and sound reproduction, eliminating the need for total darkness while making available to every class unlimited use of every audio-visual technique?

Just as surely, use of transistors and printed circuits suggests an economy of space comparable to helmet-size radio transmitters and receivers designed for men at war. There is available to every classroom in the country an inexpensive and useful teaching aid to capture present-day drama and recapture that of the past should some mechanical genius only put his talents to work for education.

An eminent psychologist in a great university is tackling the problem of building gadgets to aid in learning processes of drill and memorization, gearing his work to psychological theory and investigation. His, however, seems but a voice in the wilderness of scientific research that might well concern itself with a technological study of learning and teaching skills.

True enough, much of the learning process must remain as personalized and individualized as the work of medical practitioners. Equally true, however, are the astounding wonders performed by physicians with the aid of scientific gadgetry.

Education waits with eagerness, envy, and some apprehension for the scientific revolution to shake and remold its very foundations to meet the ever-growing challenges of the Atomic Age. Like grandmother, the con-

servative educational profession will not be likely to clasp the scientific classroom to its breast immediately, but resistance can be expected to prove even weaker than reluctance to cast out the wood-burning range and the dripping ice-box.

Far be it for a school teacher, mechanically unskilled and unlettered in scientific processes, to suggest the horizons which open before the scientist and engineer in the classroom. But, if a challenge is needed to initiate progress—here it is!

NEW ENGINEERING CENTER

United Enginering Trustees, Inc., the joint corporate agency of four major engineering societies—the American Society of Civil Engineers, the American Institute of Mining, Metallurgical and Petroleum Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers—has signed a contract for preliminary architectural plans and studies for a new Engineering Center in New York City. This is the first definite step toward construction of what is expected to make New York the "engineering capital of the world." The architects named are Shreve, Lamb, and Harmon Associates, designers of the Empire State Building and more recently of the new Brooklyn Supreme Court Building. Specific location, costs, or time of completion have not been indicated.

A DATE TO REMEMBER

June 17–21, 1957

CORNELL UNIVERSITY

ITHACA, NEW YORK

ASEE Sixty-Fifth Annual Meeting

THE COST OF A PRACTICE SCHOOL FOR CHEMICAL ENGINEERING

H. CLAY LEWIS

Professor of Chemical Engineering
Georgia Institute of Technology, Atlanta

This article supplements one by Robert C. Reid, "MIT's Practice School—An Effective Transition to Mature Engineering" in the January, 1956, JOURNAL, page 441.

By its very nature engineering is concerned with things on a large scale, and there is general agreement that the laboratory training of an engineer should include some experience with large scale operations. The most familiar devices for providing such experiences are the laboratories on the campus, equipped with large apparatus, and part-time employment in industry, which can be secured by a student individually or with the aid of a cooperative or "sandwich" plan.

A few colleges, however, use a third method, known as the practice school. Under this plan a student works in an industrial plant not as an employee but as a member of a student group under faculty supervision. The arrangement differs fundamentally from the laboratory on the campus in that a man works with actual, integrated plant operations instead of isolated pilot scale units. It differs from part-time employment in having instructional supervision by faculty members and a wide freedom in choice of activity by students.

Further, the practice school is scheduled at a late point in the curriculum, when a student has already acquired a certain amount of background in engineering subjects and is comparatively mature. Hence, practical experience is gained at the engineering level. There is no doubt that an important factor in preventing widespread adoption of the idea has been a general impression that a practice school is expensive. The purpose of this study is to examine the question of costs.

How Expensive?

From a purely financial point of view, the introduction of a new kind of laboratory is usually hard to justify in a period of static enrollment, when adoption of a new project involves abandonment of existing facilities. It is in this light that the proposal of a practice school has often been viewed in the past.

On the other hand, in a period of increasing enrollment one can often justify a new undertaking as a supplement to existing facilities. This is exactly the situation many schools face today as they prepare to handle the large increases in enrollment predicted for the coming decade. An up-to-date study of the practice school idea is therefore well worth while on financial grounds alone, aside from its educational merits.

As a guide to the magnitude of practice school expenses, an analysis can readily be made of the oldest organization of its kind, operated by the department of chemical engineer-

ing at the Massachusetts Institute of Technology. As will be seen later, the first cost is low. The principal expenses are for staff, supplies, and miscellaneous items. Inasmuch as salary levels vary between institutions, the important question is *how much* staff will be needed? Knowing this, one can readily determine the salary budget for a practice school at any given institution in the light of its personnel policies. On the other hand, the bills for supplies and miscellaneous items can be expected to be about the same at one school as at another, so these matters are treated in a section on operating expenses.

The general plan and educational philosophy of several practice schools have been described (1, 2, 3). At M.I.T. the practice school has three field stations, one at the Eastern Corporation and Penobscot Chemical Fibre Company in Bangor, Maine, a second at the Bethlehem Steel Company in Buffalo, New York, and the third at the Hercules Powder Company in Parlin, New Jersey.

(There is also a fourth station located at Oak Ridge, Tennessee, which provides instruction for students in physics, chemistry, metallurgy, mechanical engineering, nuclear engineering and related fields, as well as for students of chemical engineering. It is, therefore, in a different category from the other three stations and is not included in the present study. Its operation has been described fully by Reid.)

Undergraduates electing the practice school option spend the second semester of the senior year in the school, attending two stations for eight weeks each. Graduate students electing the practice school take a slightly longer course, previously twenty-two weeks total, with eight weeks at one station and seven at each of the other two. Beginning with 1955–56 session, however, it has been reduced to a total of eighteen weeks at the three stations, in order to adjust the time requirement more nearly to that of an academic term.

The exact number of stations is in no way important to the plan. A small institution could operate one station for a summer session or one term each year and add stations as enrollment justifies. Since the optimum number of stations varies from one institution to another, the following analysis is in terms of the cost of a single station. An outline is also given of the factors determining the best number of stations.

Initial Investment

The practice school at M.I.T. was set up just before the United States entered World War I, ran for only a few months, was shut down, and was revived again in 1920. The expenditures during this period are a matter of record, and a study of the figures indicates that the initial investment required to set up a single field station was only a few thousand "1955 dollars." No more significant analysis is possible because of the difficulties in assessing the effects of the war.

The soundest approach to an estimate of present initial investment is to consider in some detail exactly what one is going to have to pay for and then estimate the cost of these items locally. M.I.T.'s experience has been that the initial costs fall under three main headings: space, inventory, staff time, and travel.

The actual investment required to cover these headings will of course

vary with circumstances. If one can locate close to the campus, it is entirely possible to reduce the physical facilities at the plant to a negligible value; and an arrangement of this type can be useful as a means of trying out the practice school idea without a permanent commitment. However, if there are no facilities on location, a great deal of time is consumed in travel back and forth between the plant and the school. Efficient operation almost requires space for the school at the plant.

In the long run, a station at some distance from the campus is frequently desirable. There are distinct advantages to working at a large, diversified chemical plant, which can offer a broad and varied range of experiences for students and staff over a period of years. Also the same region should offer a variety of other chemical plants which can be visited by the students during their stay. One must often go some distance to find such an installation.

In addition, if a station is definitely away from the campus, there is a significant improvement in the attitude of the students. This seems to be especially true with undergraduates.

Permanent Facilities

Space. An amount of floor space is needed at least sufficient for a small laboratory, work shop, conference room and library, and private office for the director. The space at each of the three M.I.T. stations is 900 to 1500 sq. ft. At one plant, washroom and lockers are included in the station, while in two of them space is assigned in company locker rooms.

During the course of its existence the M.I.T. practice school has had eight centers in the field. In each instance, the company has provided quarters and utilities. At times the space has even been an old warehouse, laboratory, shop, or shed, which the company was no longer using, but which has been remodelled at company expense for use by the practice school.

Inventory. M.I.T. experience, particularly in the early years, indicates that the basic inventory necessary for operation is extremely small. For example, it is undoubtedly a mistake to buy a lathe or other shop equipment beyond a couple of work benches and a few common tools. In most plant tests there is only occasional need for machine work, and this is usually handled by the company shop. In fact, there is a distinct educational advantage for the student in making it necessary for him to develop good relations with company machinists.

The essential inventory also includes tables and chairs, a sink, a platform balance and an analytical balance, a small stock of pipe and fittings, laboratory glassware, thermometers, the most elementary chemicals needed for analysis, a portable Orsat apparatus, a Pitot tube, washroom furnishings and lockers, assorted cabinets, shelves, and racks for storage, office supplies, a blackboard, the necessary reference books, and miscellaneous items.

At present prices one should certainly be able to acquire a satisfactory inventory with an appropriation in the range of $2000 or less. A station starting with an inventory less than the basic minimum can increase it gradually by including in the annual operating budget a small appropriation for this purpose.

Staff Time and Travel. The negotiations involved in setting up a sta-

tion require a certain amount of time and travel. M.I.T.'s experience has been that an average of three personal contacts plus some correspondence has been sufficient. Two men have usually gone together on each trip. The expenses will of course depend a good deal on distance and other circumstances. In any case, the total should certainly not exceed $500.

Total Initial Investment per Station. In the light of the foregoing discussion, the total investment by an educational institution for permanent facilities at a practice school station is estimated at a maximum of $2500.

Number of Stations. The number of stations is determined by the total number of students enrolled in a practice school at a given time, the average size of a student group in attendance at a station, and the total length of time each group spends in the practice school. These factors are largely a matter of educational policy at a given institution. At the same time, one must keep in mind the fact that when a company extends the privilege of admission to its plant, a station must be operated for a long enough time each year to render significant service to the company.

When the factors already listed permit a choice, one must also consider how the educational returns to a student are affected by the number of stations he attends and the length of time he spends at each station. If a plant is exceptionally varied in its operations, a single station may be enough to provide a stimulating breadth of experience; but usually it is impossible to secure as much perspective in one location as in several, carefully chosen.

Operating Expenses

The annual out-of-pocket cost of operating a practice school station consists of the salaries of the staff, travel, and miscellaneous expenses (principally for supplies and repair or replacement of equipment).

Staff

M.I.T. has found that it can run a station smoothly with a full-time station director, a full-time station assistant, and a small amount of overhead direction from the campus. The latter was at one time exercised by the department head. More recently the work has been delegated to one of the professors, known as the practice school director, who devotes about half time to supervision of the chemical engineering practice school and the station at Oak Ridge, or about one eighth of his time to each station. In the present accounting, the fraction of the practice school director's total time allocable to a given station is rated as a station cost.

With the above staff, the maximum number of students that can be handled effectively at one time is considered to be from fifteen to eighteen. This limit is imposed not only by educational factors but also by the number of men that can be tolerated in even a large chemical plant without operational interference. An upper limit may also be set by the size of station facilities. Based on a limit of eighteen students per group, the minimum staff requirements are presented in Table 1 as a function of total enrollment, shown in the first vertical column. The remaining columns show the corresponding recommendations.

As indicated in Table 1, a station can be operated with only one man,

TABLE 1

MINIMUM STAFF REQUIREMENTS OF A PRACTICE SCHOOL

Total enrollment at a given time	Number of student groups	Number of students per group	Staff		
			Practice school director	Station director	Station assistants
5–9	1	5–9	1/16	1	—
10–18	1	10–18	1/8	1	1
19–27	2	5–9, 14–18	3/16	2	1
	2	10–14	3/16	2	2
28–36	2	14–18	1/4	2	2
37–45	3	5–9, 16–18, 16–18	5/16	3	2
	3	12–15	5/16	3	3
46–54	3	15–18	3/8	3	3

if the enrollment is too small to justify an assistant. There are disadvantages to this procedure, however.

For one thing, the student projects often require teams of several men each; with a small number of students there is a loss of flexibility in the program. M.I.T. experience has also been that the load on the staff does not drop off in direct proportion to the number of students. Finally, one must remember that the effectiveness of a two-man staff is often more than double that of one man, when two individuals are chosen whose personalities and talents are complementary.

If the number of students per group is reduced to a figure somewhat less than the maximum, the staff can give more attention to each individual, but the cost per student is increased. Hence, a decision as to average group size involves a balance between educational efficiency and cost per student and will vary from one institution to another, depending upon educational policy.

At M.I.T. for many years an effort has been made to secure an exceptional standard of educational achievement, even where this leads to comparatively high costs. In line with this intent, the practice school has aimed for an average group size of ten, with twelve as the maximum.

In the selection of station personnel, an important factor is the length of time a practice school is in operation each year. At M.I.T. the enrollment is sufficiently large to keep the practice school in operation during the two semesters of the regular academic year and a brief additional period. Under these conditions, assignment of a man to a station has the effect of isolating him from the intellectual activity of the campus, and a permanent assignment is highly undesirable.

The problem can be met in one of two ways. The solution adopted by M.I.T. has been to use young directors, who are assigned to the practice school for only two years of a three-year appointment. Because the men are young they are chosen very carefully, and through the years the post of station director has proven to be an effective stepping-stone to outstanding positions in industry.

An alternative policy is to assign older members of the faculty to the practice school in rotation. This in-

volves, however, more expense in moving families. If a school has a limited number of students, so that a practice school runs only a few months a year, arrangements should be made to have the station handled by men who can serve on the campus the rest of the year.

The duty of a station director is to maintain contacts with plant management, including department heads and foremen. In addition, he must have capacity for student leadership. What M.I.T. has found is that these duties can be handled by a good man in his middle twenties, provided there is regular liaison with a thoroughly experienced member of the faculty on the campus.

Early in the history of the practice school, the post of station director was usually held by a man who had just received his master's degree; more recently, the directors have held the doctorate. In the opinion of the author, an outstanding young faculty member who has just completed his work for the master's degree is more suitable, because what is needed is not the theoretical interests of the doctor but rather an interest in production problems, an engineering point of view, and facility in dealing with people.

The most important functions of the station assistant are to implement the station director's policies, especially those designed to insure that the students do not get in the way of the plant, and to help in educational supervision. He also looks after equipment and supplies.

Obviously, the post of station assistant requires far more maturity than is needed for correcting papers: experience shows that what is required is not age but judgment, plus a greater degree of supervision from the station director than is customarily given to an assistant grading papers.

Depending upon the division of responsibility between director and assistant and whether the students are undergraduate or graduate, the station assistant can be either a graduate student, who works full time at the station for one semester and then takes a full schedule of courses at the campus the next semester, or a man who has just completed the master's degree. At M.I.T. he usually has the rank of instructor.

Because of the nature of the relations between the company and the school, the station director and his assistant have a responsibility to the company which is essentially that of consultants. It is difficult to overemphasize the importance of loyalty on their part.

Thus, publications based on work in the school must always involve knowledge and approval of company personnel. At M.I.T. these limitations on academic freedom have never been irksome, but as compensation salaries are somewhat higher than for men of equal qualifications on the regular teaching staff.

Whoever serves as practice school director, whether part or full time, must be a mature individual. He is responsible for personnel and budgetary matters, preliminary orientation of the students, and also, if the situation requires it, for screening applications. Above all, he must maintain liaison and continuity of policy.

In his regular visits to a station he must keep up contacts with the key people in the company. He must also confer with the station director on such matters as problem children and major expenditures, and check up on

student achievement by sitting in on sessions at which oral progress reports are given. In short, he must be adequate for the task of establishing educational policy and supervising its implementation.

Over a period of six years, from June 30, 1948, to June 30, 1954, the expense for staff salaries at the M.I.T. practice school averaged $38 per student per week of attendance. During this period the three stations averaged 34 weeks of active operation per year, and the average number of students in each group attending a station was eight. The low enrollment is ascribed to two sharp drops in registration during the period.

When the enrollment of veteran students dropped off some years after World War II, a decrease in registration was expected but proved to be much greater than anticipated. Then, just as enrollments began to return to higher levels, the Korean War began.

The administration at M.I.T. is aware of the problem, and steps are being taken to increase the number of students per group. Had this number been ten, the figure considered by M.I.T. to be optimum, the staff expenses would have been $30 per student week. Under an educational policy permitting a group size of 16, the expense would have been $19 per student week.

Cost of Instruction. It is instructive to compare the above figures with the average cost of instruction at M.I.T. During the period in question, enrollment for the regular school year of two 16-week terms was 5200; the annual expenditure for educational staff salaries, including department heads and excluding sponsored research, was approximately $3,400,000.

This amount includes expenses for both the regular school year and the summer session; no separate account is carried for the latter. On the assumption that summer expenses were small compared to the total, the staff salaries are found to be between $20 and $21 per student week for the Institute as a whole.

One should note that the figure of $20 to $21 per student week is the average for all students, both graduate and undergraduate. The data do not allow determination of the cost for each group individually, but the cost per student for graduates is certainly well above the average. At M.I.T. the practice school is chiefly for graduates, and the minority of undergraduates who take it are in effect getting graduate instruction. Hence, some differential in cost per student between the practice school and the institution as a whole is justified. When a practice school is organized mainly for undergraduates, the average size of the student groups is normally larger than in a graduate program, and the cost per student correspondingly less.

Travel. The travel expenses of station staff to and from the station must be covered, either by an expense account or an increase in salary above that otherwise in order. In addition, funds must be provided for visits by the practice school director.

One visit by the latter to each station during the stay of each student group is a minimum; the maximum is probably a one or two day visit every other week. Some allowance for funds for occasional visits by members of the regular teaching staff at the campus is desirable. During the period under study, travel expenses were approximately $1.25 per student week, or $10 per group per week.

Miscellaneous Expenses. Over the six year period from June 30, 1948, to June 30, 1954, the expenses of the M.I.T. stations (exclusive of salaries and travel) averaged $12.50 per student week, or $100 for each group of students for each week of attendance. Of this approximately $44 went for supplies, $15 for repair and replacement of equipment, $15 to build up the equipment of the station, $15 for stenographic help in connection with reproducing student reports, and $11 for housing subsidy (to make the cost of student housing equal to that of an average dormitory room on the campus and to tide the rooming houses over brief periods between practice school sessions).

As already mentioned, the stations averaged 34 weeks of active operation per year. When the active weeks exceeded 34, the expenses per group week showed a tendency to be a little lower than $100; and conversely, when the active weeks fell below 34, the expenses tended to drift slightly above $100. Such data as exist on this point indicate an expense of perhaps $98 per group week for 40–45 active weeks per year and about $110 per group week for 12–16 active weeks per year.

When the number of students in a group exceeds eight, the expenses per group week are of course greater than $100. The experience of M.I.T. has been, however, that expenses do not go up in direct proportion to the number of students per group. When a plant test is made, the tendency is to set up nearly the same amount of equipment whether the group involved is large or small.

It is difficult for a small group to do more than collect spot data, but a large one can secure far more at little additional expense. If the group size is increased from eight to sixteen, the expenses per group week go up approximately fifty per cent.

Expenditures are also affected to some degree by the type of work assigned to the students. The M.I.T. policy has always been to do in the practice school the sort of work that cannot be done on campus. In other words, most of the work involves large scale apparatus and processes.

When a test program requires a permanent change in plant setup, such as installation of an orifice, the cost is normally borne by the plant department that proposed the test. Expenses of items for purely temporary use, or of interest to M.I.T. alone, are borne by the practice school.

Comparison of Alternative Costs

In comparing the expenses of a practice school with those of other methods of instruction, two groups of cases dependent on specific conditions need to be considered. In the first group are those situations where the establishment of a practice school would simply replace, in whole or in part, satisfactory on-campus facilities already used for education.

In these cases, while there will be some reduction in on-campus expense which can be applied to the cost of the practice school, savings will be rather small, with the result that substitution of a practice school for, say, a laboratory course will incur additional expense, notably the investment costs indicated previously and probably some net increase in annual operating cost. These cost increases could only be justified on the basis of a net gain in instructional effectiveness.

The second group includes those situations in which provision must be made for expansion of facilities to handle increased numbers of students or to replace obsolete facilities. The various alternatives in these cases usually involve major investment expenditures, as for example an engineering laboratory for a new department or substantial additions or remodeling of present facilities to handle increasing enrollment. The cost of establishing a practice school may then be extremely attractive, or at least comparable with those of the alternatives.

The long-range goal may well include both a practice school and an engineering laboratory. Each is capable of achieving results impossible with the other. However, when current resources are limited, one may have to choose between a comparatively large engineering laboratory and a small one supplemented by a practice school, or even between an engineering laboratory and a practice school alone. In all such cases it is legitimate to credit to a practice school the entire expense of maintaining and operating whatever facilities are alternative to it.

Summary

An analysis of practice school costs in the light of experience at the Massachusetts Institute of Technology reveals that the initial investment is low, being estimated as of the order of $2500 for each field station. The chief operating cost, staff salaries, is of the same order of magnitude per student per week of attendance as it is on campus, when a reasonable ratio of staff to students is maintained.

The remaining costs are competitive with those of alternative programs on campus. If the latter do not involve new facilities, introduction of a practice school course may be expected to cause a comparatively small increase in annual out-of-pocket expenses, which must be weighed against the educational advantages. On the other hand, when campus facilities are loaded to the limit and increased enrollment demands additional investment of some kind, a practice school can become extremely attractive economically.

Acknowledgement

The author wishes to express his gratitude for aid and encouragement received from the staff of the chemical engineering department of the Massachusetts Institute of Technology, especially Professor J. E. Vivian, director of the practice school.

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DEVELOPMENT OF OPERATIONS RESEARCH

DEAN W. STEBBINS

Professor of Physics
Iowa State College, Ames

A paper presented at the program of the Mathematics Division of the American Society for Engineering Education, June 28, 1956, Ames, Iowa

Some of the leaders in management several decades ago foresaw the need of making definite studies on the relation of men, materials, machines, and society. There was a definite need to optimize operations so that there would be no excess man-hours in one division while another division was waiting for materials. In small operations, such optimizations were rather easily effected by relatively simple mathematical or statistical treatment of data which were readily assembled. But as industry increased in complexity the solutions to such problems became more complicated. Even recognizing the problem and obtaining data were challenges. Hence, the need arose for a more concentrated study of the subject and we are now in the midst of studies of this type.

Growth of Operations Research

Operations research began to stand on its own feet during World War II, when selected scientifically trained civilian personnel were asked to volunteer for duty with the Navy and Air Force. At the peak of activity each service had over a hundred such individuals. Because no definite standards of training had been established for operations analysts, the ranks were filled with engineers, physicists, mathematicians, statisticians, lawyers, college presidents, biologists, and others, most of whom had good training in the "scientific method."

With the signing of the armistice many of the men elected to return to their chosen professions. However, a sufficient number elected to stay on so that operations research work has been continuous in the Air Force and the Navy. The Army has added this activity to its roster since the close of World War II.

In the Air Force, the analysts are civil servants of the Federal Government. The Navy contracts for its operations research with the Massachusetts Institute of Technology, and the Army works with Johns Hopkins University. In an effort to provide experienced personnel to be available for rapid expansion of such activity in the event of large scale hostilities in the future, the Air Force has inaugurated a standby program, comparable to the military reserve program. By contractual arrangement with several educational institutions throughout the United States, selected personnel are receiving indoctrination and experience in Air Force problems.

Not all operations research activity has been limited to the military services, however. Many large industries have launched their own operations research programs with some of their own employees serving as analysts. In other cases, organizations have

been formed to provide consulting service in operations research to small companies for whom it is not profitable to have their own group, or for larger companies seeking assistance in this field.

Of particular interest is the presence of operations research in other countries. Britain and Canada have much activity in this area. The Germans and Japanese are beginning to recognize this as a new field and probably will be quick to adapt it further. It would be interesting to know whether the Russians are using the techniques.

Since the more obvious applications are in industry, it is natural that those countries which are more industrialized should be the first to recognize its possibilities. However, the use of operations research is spreading to other fields, even to farming operations. It is quite likely that in the future less industrialized countries can profit from the use of operations research as well.

Organization of Operations Research Personnel

With the interest developed in operations research during and following the war, it was only natural that a society of those interested in the field should result. The "Operations Research Society of America" was founded in May, 1952, and incorporated in August of the same year. Membership in the Society has increased rapidly. There are now approximately 1400 members in 38 states, the District of Columbia, Puerto Rico, and 13 foreign countries. A similar organization exists in Great Britain. The Society began to publish the *Journal of the Operations Research Society of America* in 1952. It now has over 600 pages a year.

The Society is concerned with the proper development of the activity as a legitimate endeavor of suitably trained personnel. Therefore, they are anxious to set up standards of training and performance for operations research personnel. A committee on education is working closely with educational institutions to develop an adequate program. This brings us to the topic of training.

Training

Since men of different disciplines made significant contributions in operations research work during and following the war, it was not immediately obvious just what training would be best for operations analysts. After many discussions there was agreement that an operations analyst should have this minimum training: (a) a good background in mathematics (through calculus and differential equations), (b) statistics, especially probability theory, sampling theory, and mathematical statistics, (c) training in the "scientific method" and (d) training in personnel and human relations.

Short courses and seminars for operations research have been held at the Case Institute of Technology, Massachusetts Institute of Technology, Johns Hopkins University, The Moore School of Electrical Engineering at the University of Pennsylvania, Cornell University, Ohio State and possibly others.

It is now possible to obtain at Case Institute an advanced degree in Industrial Administration with a major in operations research. At Massachusetts Institute of Technology it is possible to receive an advanced degree

in operations research under a committee composed of staff members from several departments. Within a year or so, the Case Institute expects to offer a four year undergraduate curriculum in operations research, and other institutions are considering introducing courses or curricula in the field.

Research

As more work is done in the field it is becoming increasingly apparent that additional research in new techniques is required in order to be able to handle the increasingly complex problems that result from our increasingly complex industries and society. Already we have several new techniques—search theory, queuing theory, game theory, linear programming, Monte Carlo method, and information theory. These seem to be only a beginning.

As additional experience is gained in applying these techniques to specific problems, however, the mathematical manipulations also become increasingly complex. This leads to machine computation methods, and we already are reading about a "queuiac." Particularly needed are methods of providing mathematical models for complex operations and organizations so that the effect of varying selected, controllable parameters can be determined without disrupting the continuing operation. Also, with the proper type of model, tests can be conducted on operations at an accelerated rate, thereby effecting savings in time. This area of endeavor has hardly been scratched, and there are opportunities for great advances.

Thus we see that operations research has come into its own as a result of the demand by management for better information on which to base decisions. This has resulted in the development of new mathematical and statistical techniques. Still others no doubt will follow. A demand has arisen for personnel with a particular type of training, and educational institutions are beginning to answer the demand. Interest in this field is spreading around the world. Specialists in the field are organized for the purpose of establishing and maintaining standards of performance and training. Research is being done on new techniques to be used in the field. In short, operations research seems to have arrived.

COLVERT APPOINTED DEAN

William W. Colvert, registrar at Illinois Institute of Technology, Chicago, and a member of ASEE since 1935, has been appointed Dean of the Institute's Evening Division. Effective September 1, 1957, Dean Colvert will succeed the present Dean, Stanton E. Winston, who is retiring. A member of ASEE for 29 years, Dean Winston served on the General Council from 1951 to 1953. Both men have been with Illinois Institute for 38 years.

PROPOSED REORGANIZATION OF GRADUATE COURSES IN THE MECHANICS OF SOLIDS

GEORGE A. ZIZICAS

Assistant Professor of Engineering
University of California, Los Angeles

It is proposed to reorganize the graduate engineering science courses in the mechanics of solids to avoid certain inconsistencies in the logical structure of most of the presently followed subdivisions and to improve the efficiency both of teaching and learning. A unification of the analysis in elastic and inelastic ranges is advocated. It is also suggested that a subdivision of courses be guided by the *type* of idealized structures classified on the basis of relative dimensional magnitudes rather than by the mode of reaction to applied loads. The possibility of including the time-variable or dynamic effects in each course is also explored.

At present the subdivision of graduate courses in the mechanics of solids has resulted from the historical development of the various subjects. As soon as a consistent body of information was completed, a course covering that topic was initiated. Such an approach was justified and to a certain extent unavoidable as long as the body of knowledge was limited and no general subdivision based on some unified approach was considered or even thought possible.

For example, the behavior of materials and structures in the elastic range and graduate courses in elasticity were already well developed when the serious attention of engineers was first turned to the behavior in the inelastic range. As a result, separate graduate courses in plasticity were initiated. Similarly, when a substantial and very interesting body of information on the stability of elastic structures was accumulated, corresponding courses were established on the stability of all types of structures, such as columns or plates and shells, as a single subject.

The present result is that to acquire knowledge about the behavior of a single structure, such as a plate, one needs to take three different courses: theory of elasticity for the behavior of the structure in the elastic range; theory of plasticity for behavior in the inelastic range; and theory of elastic stability for possible loss of stability in the elastic range. Moreover, the possibility of loss of stability under a loading in the inelastic range is now not clearly classified under any specific course.

To be sure, in some courses on the theory of plates the problem of elastic stability is considered. But such a practice is unnecessary duplication of courses in elastic stability, and if followed for each type of structure would make a course in elastic stability superfluous.

The analysis of any type of structure with sufficient generality necessitates a knowledge of the analysis of stress, strain, and stress-strain relations. The first two parts, the analysis of stress and the analysis of strain, are identical and necessary to both

the theory of elasticity and the theory of plasticity. The knowledge of elastic stress-strain relations is needed for the complete formulation of the inelastic. Hence a considerable duplication of the theory of elasticity is unavoidable in a treatment of the theory of plasticity.

More serious, however, is the development of certain concepts of linearity in the theory of elasticity that have to be systematically dispelled when a course in the theory of plasticity is undertaken. Most conspicuous is that of superimposing results for finite loading. In addition, the unifying factor that the elastic and inelastic behavior refer to the same material for different intensities of the applied load is not clearly discernible by treating the two ranges in separate courses.

Only a few decades ago, the amount of knowledge about the mechanics of deformable solids was such that it could be reasonably covered in a few graduate courses. Then the breakdown of the field into subjects was not critical. The student was given all the available information anyway.

Today the situation is different. Even a cursory study of the papers published during a year's time in any particular subject would require more time than any standard graduate course can be reasonably allowed. Thus an efficient organization of graduate level teaching becomes of greater necessity than ever before.

Fortunately the basic theories, principles, and methods of attack still can be treated in a suitable sequence of courses. It is the contention of the author that optimum efficiency in teaching and learning can be best achieved by a division of the general subject based on the natural interest of the engineer in learning all possible patterns of behavior for each structure (rod, plate, or shell) rather than each pattern of behavior (elastic, inelastic, or stable) for all types of structures.

One more differentiation seems advisable. Advanced graduate work in mechanics of solids may aim primarily at a better understanding of behavior and the improvement of basic theory by which certain idealized structures are analyzed. Such study is undertaken in graduate engineering science courses in the area of mechanics of solids, leading to the degree of Master of Science, Doctor of Philosophy, or Doctor of Enginering Science.

Graduate work in the area under discussion, however, may also prepare the student to apply the available advanced techniques for an optimum result in actual design of specified structures using suitable materials. Such an approach is followed for graduate courses in structural design. Then, professional proficiency is the purpose and the degree of Master or Doctor of Engineering is sought.

For the sake of completeness, the present paper is restricted to courses given primarily to candidates for the degree of Master of Science, Doctor of Philosophy, or Doctor of Engineering Science. In this group the subject of mechanics or physics of the solid state is increasingly becoming a standard item in the engineering curriculum. The subject matter is limited, naturally, to the theory relevant for engineering applications, both present and potential.

Principles of Reorganization

To summarize, the principles upon which reorganization is recommended can be stated as follows:

(a) two separate and parallel lines of courses—one for engineering science or analysis and one for engineering design;

(b) unified treatment of basic theory in elasticity and plasticity;

(c) breakdown of subject matter into individual courses by type or dimensionality of structure rather than by behavior;

(d) possible inclusion in the future of time-variable effects or dynamics in each course.

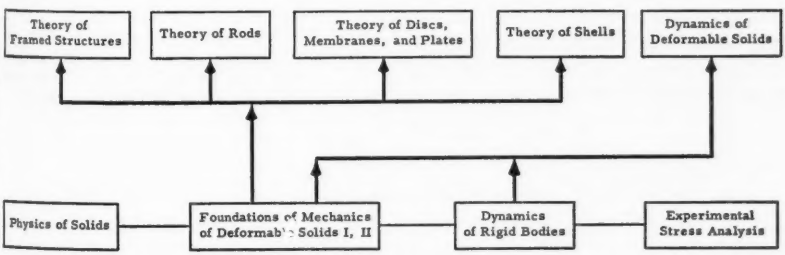
Typical Set of Courses

Based on the foregoing principles, a possible division of courses is indicated in schematic form as Figure 1. The four courses along the first horizontal line could be taken concurrently. The course on Foundations of Mechanics of Deformable Solids could be a two-semester course with three units per semester; the first semester would cover isotropic materials and small strains, while the second could deal with three-dimensional problems, anisotropic materials, and large strains. The other three subjects on the first line are considered as one semester, three-unit, courses.

The course on the theory of rods relates to bodies with on dimension much smaller than the other two (as beams, columns, or shafts). The course on the theory of discs, membranes, and plates is concerned with flat or almost flat bodies having one dimension much smaller than the other two. The subject of curved two-dimensional solids or shells is treated separately both to avoid overcrowding the first course, and to allow for the considerable amount of special mathematical preparation needed in advanced shell theory.

It is hoped that eventually the subject of dynamics of deformable solids will be distributed among the appropriate specialized courses so that the organization of courses will gain additional logical clarity and teaching efficiency will be increased. Static behavior, after all, is only a limiting case of dynamic behavior with small accelerations and high damping. The resulting organization of courses is represented in Figure 2.

In this connection, it is felt that an increase in the number of regular graduate courses should be discouraged. Rather, the student should be prepared sufficiently in the fundamentals to be able to read current scientific literature. The more narrow and intensive study should be undertaken in engineering seminars, leading eventually to thesis or dissertation work and further original research.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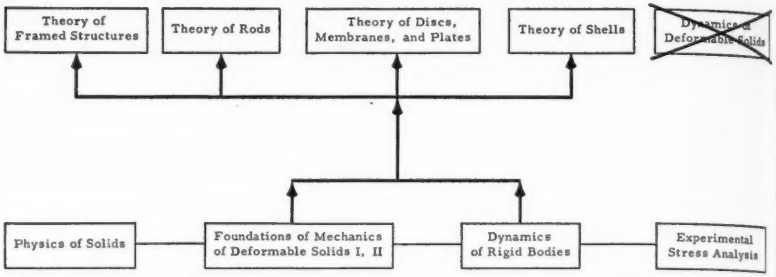
Theory of Rods
Theory of Discs, Membranes, and Plates
Theory of Shells
Dynamics of Deformable Solids
Physics of Solids
Foundations of Mechanics of Deformable Solids I, II
Dynamics of Rigid Bodies
Experimental Stress Analysis

FIGURE 1. *Proposed interim organization of graduate courses in the mechanics of solids.*


Theory of Framed Structures
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Theory of Discs, Membranes, and Plates
Theory of Shells
Dynamics of Deformable Solids
Physics of Solids
Foundations of Mechanics of Deformable Solids I, II
Dynamics of Rigid Bodies
Experimental Stress Analysis

FIGURE 2. *Proposed final organization of graduate courses in the mechanics of solids.*

Concluding Remarks

The author has given during the fall semester a graduate course in "Mechanics of Deformable Solids," which corresponds to the course on the "Foundations of Mechanics of Deformable Solids" discussed here. The response of the students has been very favorable. A course in the theory of plates is also scheduled for the spring semester of 1957. Therefore, the first indications are that the proposals made are workable in practice.

It should be pointed out that elements of the proposed reorganization have already been incorporated in various treatments of the general subject. A. Nadai (1, 2) includes a certain amount of elastic analysis in his book, especially in the second edition. H. M. Westergaard (3), in his partially finished text, treats elasticity and plasticity simultaneously, although the integration is not complete. A certain amount of elastic along with inelastic behavior, on stress-strain relations primarily, is also followed by A. M. Freudenthal (4) and by O. Hoffman and G. Sachs (5).

The time therefore appears ripe for a discussion of more complete reorganization. It is hoped that the proposals made in this paper will be of value in such an effort and stimulate further discussion of this important educational question.

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NEW PUBLICATIONS AND SERVICES

COLLEGE-INDUSTRY CONFERENCE PROCEEDINGS AVAILABLE

The *Proceedings* of the 8th Annual College-Industry Conference held on January 26, 1956, at Marquette University recently have been published. They are a collection of the papers presently at the Conference, which was sponsored jointly by the ASEE Relations With Industry Division and the Wisconsin Society of Professional Engineers. Copies are available in limited quantity from R. J. Panlener, Director of Industrial Relations, Marquette University, Milwaukee 3, Wisconsin, for $1.00 each.

"RESEARCH—KEY TO PROGRESS" FILM

The Armour Research Foundation of the Illinois Institute of Technology has produced a 15-minute color motion picture on industrial research, tracing its phenomenal rise and its many contributions to the high standard of living in the U. S. The 16 mm. film has been produced by the Foundation as a public service and is available to industrial, education, professional, civic, and other groups. For further information write to Public Relations Department, Armour Research Foundation, 10 West 35th Street, Chicago 16, Illinois.

RESEARCH SERVICES AVAILABLE

A new research organization has been established in London to provide assistance with academic projects over a wide field. It is able to provide translations, extracts from or photostatic copies of written or printed materials, bibliographical information, and generally to undertake all work of a similar description.

Specialist services are available in medical, legal, economic, historical, and other fields of study, and can provide assistance in locating materials from British and European sources. Fees are dependent upon the time involved and expenses incurred on any particular project, and will be quoted on inquiry. Further information can be obtained from The Research Agency, 10 Clorane Gardens, Hampstead, London, N.W. 3, England.

AERONAUTICAL DIVISION BULLETIN

V. S. HANEMAN, JR.

Assistant Professor of Aeronautical Engineering
AF Institute of Technology, Box 3309, Wright-Patterson AFB, Ohio

The opportunity to publish articles of interest to the members of the Aeronautical Division and to provide a means of communication is appreciated beyond measure. We hope that the articles published here will be of interest to all fields and spur greater activity throughout engineering education.

Of the many problems facing us in the field of Aeronautical Engineering Education one of the greatest is the technique of presenting theory and practice to the student by use of training aids. With the advent of each major breakthrough in our field, a whole new alignment of course material may become necessary to bring our students up to the level required to accomplish their assignments upon graduation. The use of training aids to fix certain fundamentals in the students' minds has many advantages but certain limitations as well.

At the annual meeting in Cornell this June there will be a panel discussion by our Division on the use of training aids. Professor Ernest Anderson has arranged for experts from several schools as well as from the Air Force and the Navy to present their views on this vital topic. Your experience may prove to be of great value to us in the general discussion. If you cannot attend this meeting, would you please drop Profesor Anderson a note so that your ideas can be included in the program?

The major activity of the Division in the past few years has been directed toward the goal of having representation of Aeronautical Engineering on the Engineers' Council for Professional Development. Through the efforts of many people, led by Professor John Hoover, our Institute of Aeronautical Sciences has written ECPD requesting consideration for membership on that body. This action was approved by the IAS Council last January and the information was made available to us at the Winter meeting of the Aeronautical Division.

At that meeting it was also decided that a formal set of by-laws would assist in creating a more active Division. These have been composed and were sent to the active members in April. The by-laws will be voted upon at Cornell in June.

Of the 205 members of the Aeronautical Division listed in the current Membership Directory, only 27 attended the Ames meeting. Let us try to out-do the Mechanics Division at Cornell this year!

EXECUTIVE COMMITTEE

J. HOOVER	*President*	University of Florida
J. COAN	*Vice-President*	University of Illinois
E. ANDERSON	*Secretary*	Iowa State College
D. PEERY	*Council Representative*	University of Michigan

Editor *pro tem*—MAJOR V. S. HANEMAN, JR., AFIT

NEW CURRICULA

SYRACUSE SIX-YEAR PROGRAM

Syracuse University College of Engineering, through the agency of the University College and the adult education division, has made available a complete undergraduate program in engineering on a part-time basis. The first two sessions are expanded over four years so that students can maintain a full working schedule with their employing company while completing the freshman and sophomore years. Students completing the four-year program have the option of taking an Associate Degree in engineering or of completing the requirements for the bachelor's degree by full-time attendance at a university of their choice.

The six-year program in engineering is designed to expand high-quality apprenticeship training programs now part of the educational opportunities of many large industrial organizations. Both Carrier Corporation and the General Electric Company in Syracuse have made arrangements so that students who complete satisfactorily the four-calendar-year schedule will be permitted to take the final two years in residence at an engineering college with all or a substantial portion of the tuition borne by the sponsoring company. Although the six-year program is designed to meet the critical needs of industrial employers, qualified persons who wish to pursue the course at their own expense may do so.

NEW SANITARY ENGINEERING PROGRAM

The Civil Engineering Department of the University of Cincinnati Graduate School of Arts and Sciences will offer in June and September a new graduate program leading to a Master of Science degree in Sanitary Engineering. Joining with the Civil Engineering Department, the Institute of Industrial Health, and the Kettering Laboratory of the University are the local Robert A. Taft Sanitary Engineering Center (national research laboratory of the United States Public Health Service), and the Ohio River Valley Water Sanitation Commission. Engineers and scientists from all these organizations will assist in formulating and staffing the new courses.

PROBLEMS OF INDUSTRY RAIDS ON UNIVERSITY FACULTIES

JOHN D. AKERMAN

Professor and Head, Department of Aeronautical Engineering
Director of Rosemount Aeronautical Laboratories
University of Minnesota, Minneapolis

A paper presented at the joint ASEE-Institute of the Aeronautical Sciences meeting, New York City, January 30, 1957. Recommended for publication by the Aeronautical Division.

For those who expect violent condemning, complaining, or accusations of the aeronautical industry, this presentation will be a disappointment. As in any case where sociological or economical problems are raised, the solution can be reached only when facts are exposed and solutions sought in a rational, nonbelligerent manner.

Very often a bad situation is emphasized and attributed to a single cause. So in this case, very often, the industry is pictured as the bad wolf, who is bad just because he wants to be bad. Maybe the pot is calling the kettle black when the real trouble is simply a shortage of scientific personnel to satisfy the needs of the universities and the industry.

The problem is mutual and will not be eliminated until we have enough scientific personnel to satisfy the needs for both of them. In the meantime, we will have to find a mutual working arrangement so that both parties can proceed with their responsibilities without handicapping each other.

The conflict between universities and industries became particularly acute last spring. Then most departments found that they had to increase their staffs to meet the advancing wave of a increased enrollment in senior and junior years. The staffs were already at a minimum, as a result of the preceding low enrollment.

In this situation the loss of faculty members of senior rank was very critical for three reasons:

1. There was no free supply of experienced personnel.
2. The experienced personnel were particularly in demand by the aeronautical industry.
3. Top teaching positions could not be filled with young men from assistant or instructor ranks.

So the two-way raiding was on, with the ultimate result that neither industry nor the educational institutions had all the personnel they needed.

Restraint Needed

It is natural that in such a competitive market there were cases where some of the participants did not observe the expected rules of the "ring" and delivered some heavy "blows below the belt." Those exceptional cases more than anything else caused explosive expressions similar to the title of this paper. If in the future we can eliminate these blows "below the belt" we would be able to stew in our prob-

lems more smoothly and achieve better results without causing "atomic explosions" in university-industry relations or efforts.

Let us look at the facts. In this case, I selected only aeronautical engineering departments and their loss of personnel to industry at the end of the school year 1956–57. There are some broader studies of this nature being carried out by other investigators, and their findings will be available in due time. From experience I know how most administrators feel when they receive another questionnaire. Therefore, I made my questionnaire very short so that department heads could fill it out in two or three minutes.

For a spot check on the general situation, I sent several slightly different short questionnaires to the deans of the same schools.

The first question was: "Approximate Number of Teaching Staff Hired by Industry."

The answers from 23 department heads of aeronautical engineering totaled 15, of which 9 reported the loss of one faculty member, 3 reported 2, and 9 none. Although the figures are not very impressive, they may be very disastrous in some cases. The loss of a man may eliminate a complete series of courses essential in one field of aeronautical engineering education or, as in one case, where two transfers into industry coincided with one death, one retirement, and one promotion to an administrative job in another institution. Usually where such a heavy loss took place it was a big institution, and it was able to secure some new professors, or make internal adjustments within remaining faculty.

The second question was: "What is the Approximate Number of Research Staff Whom You Expected or Wanted to Remain That Went to Industry?"

Again for the 23 departments the total number of persons lost was 46. One institution lost 15, 2 lost 5, 2 lost 4, 2 lost 3, and 2 lost 2, while 9 lost none. The remarks concerning the number may be the same as those for the first question, except that in this case the institutions might have had a better chance to secure new substitute research workers from their own trainees than the industries. Here the universities have another attraction in that they can offer opportunities for definite, continuous study toward advanced degrees.

The third question was: "What Is the Approximate Per Cent of Salary Increases Received by Men Who Left for Industry?"

Only 2 cases reported an increase of 20%, one of 25 % and one of 40%. The rest of the cases ranged from 50% to 100%, with the majority of cases of 80, 90, and 100%.

However, if anybody draws the conclusion that money is the only attraction to industry, he would make a grave mistake. There are some very weak spots on the universities' side and some other very good inducements on the side of industry. To mention just a few: slow advancement in academic life, requirements of Ph.D. degrees to reach top positions in education, better opportunity to select fields of specialization in industry, and many others.

A very good discussion of the "pros and cons" on this subject can be found in an article by Mr. R. N. Dyer in the December, 1956, issue of the JOURNAL.

A Dark Future

A sad picture unfolds when we look into the future. As of September,

1957, the same 23 departments report that they have vacancies for 11 full professors, 10 associate professors, 20 assistant professors, and 17 instructors. We can see that even if the industries had not taken from the universities the 15 men reported in question No. 1, the aeronautical schools still would be 41 teaching staff members short. Therefore, the problem of shortage of teaching staff is critical by itself, and has to be solved by the universities in some other way.

Possible Feedback

There is another side of the coin. Two department heads reported that each of them had hired two outstanding men from the industry for their teaching staff. How many did not report hiring the middle rank persons from the industry to join the university teaching and research staff, is not known from the replies.

It is obvious that the transfer from universities to the industries is not the major cause of complaints, but that the need for the larger staff at the universities is the real cause. Employment by industry, and particularly some bad ethics or, as I called them above, "blows below the belt," are only the effects of the situation.

I would like to mention that the worst practice is to approach an institution and offer to hire, at a very high salary, a top staff member and his assistants in a particular field as far down as they go. It is obvious that such a practice is destructive and the most vicious.

Just as bad a practice is to take two top men and their immediate assistants in the same field of specialization. A third form, very ineffective but very annoying, is to make super colossal-Hollywood announcements as, for example: "We will hire every Ph.D. available at this price" or "*There will be awarded in sciences, in the whole United States, 3,000 Ph.D.'s this year.* Our company must and will hire 1,500."

Such tactics, like the three worst samples mentioned above, or similar ones, are regrettable, but they nevertheless exist. Fortunately they often backfire with very unexpected results. I would like to emphasize that established older companies, big or small, follow sound and decent policies and never use methods described above. It is mostly the newcomers, the "Johnny come latelies," and the "Billion dollar wonders" who are the most frequent users of such methods.

Comments Made

From my colleagues I received, without solicitation, some very interesting remarks along with the questionnaires. I am quoting some of them for your judgment.

"I do not believe that industry is raiding our faculties any more than they are raiding each other and the government research laboratories. It is a vicious cycle and we unfortunately have been left at the bottom of the spiral. . . . The fact remains that they are building up their own research laboratories as rapidly as possible. I heard many of the industrial people remark that they felt they could do the research as well as the NACA."

I personally have heard remarks that even post-graduate education also can be done by the industry as well as by the university—then why the rush for the trained people?

"There is another problem of vital importance concerning the lure of industry to many students who should remain in

school for graduate work. Many of the potential graduate students, if allowed to earn a graduate degree and make a decent living, would go into teaching and research. We are critically short of qualified staff."

"Professor to whom you addressed this inquiry was one who left."

"I just hired from industry an assistant professor to start January 1957. We are trying to match salaries by giving 11 month instead of 9 month appointments. This has been successful during the past two years."

"Unless we can make substantial salary adjustments this year we face serious trouble."

"The title of your paper implies that it is improper for an industry to try to employ faculty members. I feel that this is so unfair to the faculty. Faculty membership must be made sufficiently attractive that they would not be raidable."

I agree 100 per cent with this statement except for the interpretation for the title of this paper.

"We are lucky. We lost only one with 20 per cent increase in salary."

If this person was really good I am sure that his university would have found the money to increase his salary 20 per cent.

"Over the past few years, we have had men whom we particularly wanted to keep, leave us for industry employment. . . . Our main problem has been to find top flight young men and attract them to a teaching career . . . because of very high starting salaries offered by industry compared with those offered by universities."

"We lost an undetermined number of prospects who visited us, were interested in joining our staff, but did not do so for financial reasons. One really good man showed me his salary offer which, estimated with fringe benefits, was 2½ times our best possible offer."

"Our greatest aid in holding men has been full summer employment and additional allowance for men engaged in overtime sponsored research. One man returned after reaching $22,000 a year in industry to his old position at $9,000 for 9 months. We acquired an outstanding man from industry with this *supplement.*"

"It would be very bad for the teaching profession if the industry would not offer advancement and opportunities for our professors."

In my own experience a man in the industry qualified for a top rank position (except for a Ph.D.) came to the conclusion that the university's salary would almost equal the income tax he pays on his present compensation.

Conclusions

It is obvious that the raiding is not so vicious except for some exceptionally unethical cases. The shortage of scientific personnel now plaguing this country is for the first time reaching the universities. The salary scale at the universities is far from the level where it should be on the economic scale of the country. The time is gone when men with outstanding scientific abilities had a chance only at the universities to satisfy their desire for research and teaching, and they had to work for universities for unbelievably low compensation. The industry has awakened to the realization of the value of the knowledge possessed by academic personnel and therefore the adjustments to this situation by the universities and the industries should be made. It is foolish for the industry to imagine that with money and numbers of employees hired they will accomplish the same as what universities are doing or could do. It is just

as unreasonable for the universities to assume that they can keep the best brains in the ivory towers, isolated in a "status quo," without adjusting university policies to the modern world.

Recommendations

There cannot be set up a list of rules which would solve this dilemma, but a few successful means, which worked out well in some cases, should be mentioned:

1. Provide opportunities for professors to do research work with necessary equipment and assistants in a chosen field. Many professors would have gone into industry if their research could have been confined to paper and pencil. Many industrial research men have joined universities because they liked teaching and research instead of research alone.

2. Provide opportunities to earn a decent living through liberal scholarships or part-time work to graduates so that they can remain at universities and pursue studies toward higher academic degrees for academic careers.

3. A very obvious help is increases in salaries for academic people, whether they are on nine or twelve month appointments. It certainly is not a help to the universities that a man has to go out for three months into industry to secure a paycheck for the three summer months so that he can work at low compensation for the next nine.

4. Provide extra compensation for outside contract research work carried on by teaching personnel. It is very unjust that two men of the same rank, doing approximately the same teaching, should get the same compensation, when one does his research, at the university's expense, at his own tempo or not at all, while the other creates opportunity for himself and a number of assistants to do research in his specialty which requires facilities and equipment beyond the capabilities of the university to provide. He will do it with intensity and with no cost to the university and on funds provided from outside.

5. There have been some very successful cases where outstanding professors could not remain at the university at their salaries when industries all around them were eager to hire them with double salaries. Since industry does not need such men for eight hours routine work, but for their ideas, experience, and advice, proper arrangements can be made where the university allows time for outside consultation. Industry can then make a long-range contract for consultations at fixed salaries with fixed maximum-time requirements. Thus, the university retains an outstanding professor who is not excluded from following the latest industrial developments in his field; industry has secured the service of this man for work where he really contributes with his knowledge and experience without wasting his time on routine. The professor is happy to do his university work, be connected with industrial developments in his field, and have a big enough income to satisfy his needs.

This arrangement has worked out satisfactorily for outstanding men in many institutions, but it requires sound judgment and foresight from all three parties involved.

6. It may be wise for the universities to realize that there are outstanding men in the industry who would like to join the academic group

and who would be a contribution to the best of the university faculties even if they have not a Ph.D., a must for top academic rank. As it is now, who will join a faculty if he sees that a lack of the Ph.D. is an iron curtain for him from the start to the finish of his career?

7. By all means avoid "mass-evacuation" of faculties by industry from one institution, or the use of other methods of recruiting which so obviously harm both parties.

8. Allow time off from industry for personnel to teach special courses at colleges and universities.

CANDID COMMENT

The Ideal Author

To whoever went over these galleys so carefully before sending them to me:

I *hope* the one slip in spelling was not in my MS, but anything is possible after thirty-five years of teaching Freshmen.

The slip in *grammar* probably *was* in the MS. I, who once could say "none is" naturally, am beginning to succumb to our modern vagueness about agreement of the verb. Thanks for pointing it out. It is now corrected.

I struggled manfully to help out with your widows and breaks, only to realize that if you insert the subtitles (which are all very nice, and should go in) everything will be thrown out again. So you will have to use your judgment alone anyway. I think, however, that the slight shortening of the ending to save a line is really an improvement, as are some of the other changes.

Whatever change you have to make will probably be an improvement too. As Samuel Johnson once said to a fawning lady who was maintaining that his one-draft *Rambler* papers were absolute perfection: "Madam, there is nothing that was ever written which could not be improved by rewriting." So do your derndest.

DISCUSSION OF GITZENDANNER ON RISK ANALYSIS

JAMES B. WEAVER

Assistant Director, Economic Evaluation Department
Atlas Powder Company, Wilmington, Delaware

MARY ANNE STORMFELTZ

E. I. duPont de Nemours and Company, Inc., Wilmington, Delaware

In the months which have elapsed since the original questions were raised, the "comments" have developed almost to the status of an original article, and are here presented as such.

The technique described in the paper, "Risk Analysis in Engineering Economy Studies," by F. A. Gitzendanner in the JOURNAL, October, 1955, is of considerable interest to us. We would like to follow the sample case presented through to the conclusion drawn in Figure 3. Our analysis of Figures 1 and 2, however, indicates that some confusion exists either in the equation of Figure 1 or in the terminology used to set up the alternative courses of action.

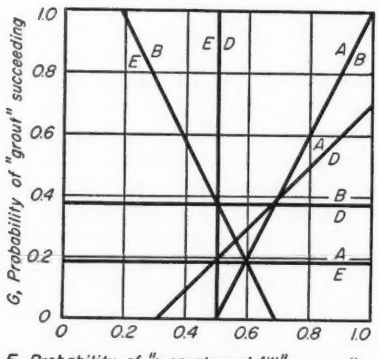

FIGURE 1. *Revised by Weaver and Stormfeltz from Gitzendanner.*

In Fig. 1, line A/B was first marked 2G–F = 1, but since G = 0 at F = 0.5, we believe the author may have intended 2F–G = 1. We then believe the areas "A preferred" and "B preferred" are reversed, since above the break-even line B will be more costly.

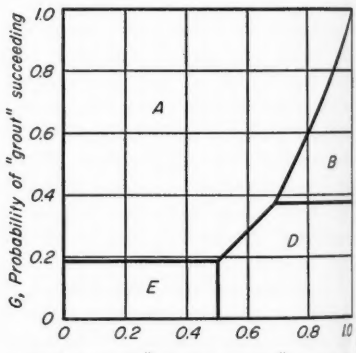

FIGURE 2. *Revised by Weaver and Stormfeltz from Gitzendanner.*

In Figure 2, the horizontal line at about G = 0.19 indicates to us the choice between Course A and Course E, rather than B and E as

shown. We, therefore, suspect the terminology for Cases A and B may have been reversed after the graphs were prepared.

We would appreciate your clearing up this minor point so that we can complete our analysis of the methods. Copies of our calculations are attached for clarity.

Gitzendanner Accepts

Mr. Gitzendanner has accepted the comments, with the reply below: I have checked the calculation details of the published article, which was abstracted from a previously prepared internal company memorandum, and find that cases A and B were inadvertently reversed at some time during the preparation of the publication copy. Incidentally, the charts which accompanied the comment, and which are slightly different from the one shown in the published paper, are also correct.

Weaver: Results of Calculations

These calculations have eliminated from consideration Course C, Excavate, Grout and Move, and, in summary, have indicated areas of preference for the remaining alternatives, as shown in Figure 2.

Case I considered above was that in which no steps would cause damage to tank, give information for subsequent steps, or affect cost of subsequent steps. Therefore, the remaining three-step alternative (Course B –Grout, Excavate and Move) need not be decided on in its entirety; after grouting, if it is unsuccessful, a separate decision can later be made to excavate or to more. Therefore the real current choice is expressed as shown in Figure 3. (Note, however, that the existence of Course B diminishes the area of preference for "excavate" to the horizontal top level shown.)

If the chance is equal of the correct probability values for F and G lying anywhere in the area, it is apparent that the best step is to grout. However, Mr. Gitzendanner states that the probability of successful grout, whatever it is, is probably less than that of successful excavation. The area for consideration is therefore only that to the right of the indicated diagonal. Again assuming an equal chance of the correct probabilities lying anywhere in the area, the grout is the

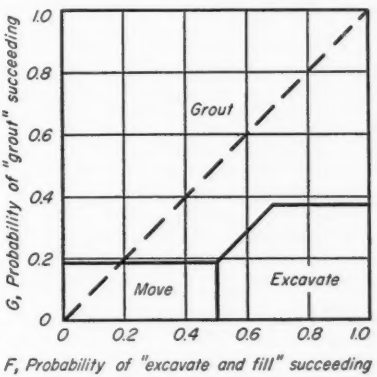

FIGURE 3. *Revised by Weaver and Stormfeltz from Gitzendanner.*

proper first choice by the ratio of areas shown (6 : 4·5 : 2, Grout : Excavate : Move). Since Mr. Gitzendanner says there is general agreement on a 20% or better chance of success for grout, the ratio of preference for grout is higher, and moving has no chance of being cheapest. Were the chance of success sure to be over 40% for grout, no other alternative could be cheaper as a first choice.

Procedure if Grout Unsuccessful.

Mr. Gitzendanner states that grouting was undertaken and was successful. It is interesting to consider the application of the method assuming failure of grouting. The $30,000 spent for grouting then becomes a "sunk cost" and of no relevance in later decisions. The chance of success of grouting is established as zero, so the second decision must be made based on the bottom horizontal line of the attached figures. Note that the relevant choices (A vs. B and E vs. D) intersect at the same point on this line, $F = 0.5$. If the chance of success of excavation is deemed to be over 50%, it is still worth excavating before moving.

CORRECTED EXAMPLE OF RISK ANALYSIS

Method	Cost of Method	Probability of Success
1. Grout under tank	$30,000	G
2. Excavate and fill	80,000	F
3. Relocate tank	160,000	1.0

Case I—Assume:

(1) no damage to tank from any of the repairs
(2) cost not influenced by earlier steps
(3) no useful information gained during repairs

Courses of Action for Case I	Probable cost of course (i.e. average cost)
A.—Grout and Move	$30\,G + 190\,(1 - G)$
B.—Grout, Excavate and Move	$30\,G + 110\,(F - G) + 270\,(1 - F)$
C.—Excavate, Grout and Move	$80\,F + 110\,(G - F) + 270\,(1 - G)$
D.—Excavate and Move	$80\,F + 240\,(1 - F)$
E.—Move	160

These can be simplified as follows:

Course	Cost of Course
A—Grout and Move	190–160 G
B—Grout, Excavate and Move	270–160 F–80 G
C—Excavate, Grout and Move	270–160 G–30 F
D—Excavate and Move	240–160 F
E—Move	160

Equate costs of courses to obtain break-even lines:

1. Cost A = Cost B

$$190\text{–}160\,G = 270\text{–}160\,F\text{–}80\,G$$
$$0 = 80\text{–}160\,F + 80\,G$$
$$2\,F\text{–}G = 1 \qquad (F = 0.5,\ G = 0;\ F = 1.0,\ G = 1.0)$$

For values of G above the break-even line, Course A is preferred to Course B, as A's cost is lower. Example

$$F = 0.5, \quad G = 0.5$$
$$\text{Cost A} = 190\text{–}160\,(0.5) = 110$$
$$\text{Cost B} = 270\text{–}160\,(0.5)\text{–}80\,(0.5) = 150$$

2. Cost A = Cost C

$$190 - 160\,G = 270 - 160\,G - 30\,F$$
$$0 = 80 - 30\,F$$
$$F = 8/3 = 2.67$$

For values of F less than 2.67, Course A is preferred to Course C as A's cost is lower. Thus, by our definition where F does not exceed 1.0, Course A will always be preferred to Course C; there is no need to compare Course C to Courses B, D, and E.

3. Cost A = Cost D

$$190 - 160\,G = 240 - 160\,F$$
$$0 = 50 + 160\,G - 160\,F$$
$$3.2\,F - 3.2\,G = 1 \qquad (F = 0.31,\ G = 0;\ F = 1.0,\ G = 0.69)$$

For values of G above the break-even line, course A is preferred to Course D, as A's cost is lower. Example:

$$F = 0.31, \quad G = 0.5$$
$$\text{Cost A} = 190 - 160\,(0.5) = 110$$
$$\text{Cost D} = 240 - 160\,(0.31) = 190$$

4. Cost A = Cost E

$$190 - 160\,G = 160$$
$$30 = 160\,G$$
$$G = 3/16 = 0.1875$$

For values of G higher than 0.1875, Course A is preferred to Course E, as A's cost is lower.

5. Cost B = Cost D

$$270 - 160\,F - 80\,G = 240 - 160\,F$$
$$30 = 80\,G$$
$$G = 3/8 = 0.375$$

For values of G higher than 0.375, Course B is preferred to Course D, as B's cost is lower.

6. Cost B = Cost E

$$270 - 160\,F - 80\,G = 160$$
$$160\,F + 80\,G = 110$$
$$2\,F + \quad G = 1.375 \qquad (F = 0.1875,\ G = 1.0;\ F = 0.6875,\ G = 0)$$

For values of G above the break-even line, Course B is preferred to Course E, as B's cost is lower.

7. Cost D = Cost E

$$240 - 160\,F = 160$$
$$80 = 160\,F$$
$$F = 0.5$$

For values of F higher than 0.5, Course D is preferred to Course E, as D's cost is lower.

Using the above relations, a graph can be obtained showing preferences. (Figure 1.)

MINUTES OF ECRC EXECUTIVE COMMITTEE

Chicago, February 28, 1957

This is the first publication of ECRC minutes in the JOURNAL; it is hoped that in future such abstracts can be presented regularly.

This meeting of the Executive Committee was devoted to a review of the program to be presented by the Engineering College Research Council at the next annual meeting of the American Society for Engineering Education at Cornell in June, to committee activities, and to publication and budgetary matters.

The program will consist of an afternoon session (Tuesday, June 18) to which University Presidents as well as Engineering Deans and Directors of Research will be invited, and a morning session (Wednesday, June 19), open to all A.S.E.E. members as well as to the special guests. The theme of the afternoon conference is to be "Engineering College Salary Administration Policies and Practices Affecting Engineering Research." The general topic of the morning formal session will be "Encouragement of Research and Graduate Programs through the Efficient Use of Educational Manpower and Facilities."

Two unusual features at this year's annual meeting will be the invitation to University Presidents, and the avoidance of conflicts between sessions sponsored by the E.C.R.C. with those sponsored by the E.C.A.C. In order to effect this, the E.C.R.C. will forego one afternoon session and will cooperate with, and support, the E.C.A.C. afternoon conference of the Military Affairs Committee on Wednesday, June 19.

The relations between the Engineering Colleges and the National Science Foundation, together with methods for keeping the colleges better informed about the Foundation's activities, were discussed, and certain actions were recommended. Progress was reported by the Committees on Research Capabilities in Engineering Colleges, and on Relations with Industrial Research Agencies.

The Awards Committees reported that the names of a number of candidates already had been received and that the committees would soon meet to make their recommendations for the two awards. The Vincent Bendix Award was first presented at the June 1956 A.S.E.E. meeting, and the Curtis W. McGraw Research Award will be presented for the first time at the 1957 A.S.E.E. meeting.

The procedure to be followed in the publication of the 1957 *Engineering College Research Review* was established. Although every attempt will be made to have the issue ready for the June meeting, no copies of the publication will be released until it is complete with index.

A budget for fiscal 1957 was presented and approved. This budget was for all activities other than the printing of the *Review*, which was considered separately.

TEACHING POSITIONS AVAILABLE

MECHANICAL ENGINEERING POSITION to teach undergraduate courses in thermo-fluids and heat transfer. M.S. or Ph.D. Opportunity for graduate study, industrial consulting, or research. Start September, 1957. University of Santa Clara, Santa Clara, California.

CIVIL ENGINEERING RESEARCH positions of various grades open in Highway, Sanitation, Hydraulics, and Construction Materials. Will provide wonderful opportunities for professional training and advancement, early individual responsibilities, published findings, and excellent employment conditions. Write to G. A. Riedesel, Division of Industrial Research, State College of Washington, Pullman.

CIVIL ENGINEERING HEAD needed at progressive engineering college with established program and reputation in Civil Engineering. Present program at Doctorate level. New facilities. Need man with experience at all levels of instruction, and interest in research. Prefer Ph.D. with administrative experience in engineering education, but will consider less experience. Good leader. Salary open. Write to Dean of Engineering, Colorado State University, Fort Collins, Colorado.

OPENING IN EXPANDING METALLURGICAL Engineering Department of privately endowed eastern college offering engineering and liberal arts degrees. Rank and salary open. Teaching ability in any metallurgical field can be used. Reasonable teaching load. Position open September 1, 1957. Location of school and facilities attractive for man to engage in consulting and research. Graduate studies offered at nearby locations. JUN-1.

AERONAUTICAL ENGINEERING Assistant Professor needed to teach structures and other courses in aeronautical engineering curriculum. M.S. degree required and experience desired, but not required. Salary commensurate with training and experience. Opportunities for research. Please forward complete details of education, professional experience and personal background to Dean L. R. Quarles, School of Engineering, University of Virginia, Charlottesville, Virginia.

DRAWING AND ELECTRICAL STAFF openings at B.S., M.S., or Ph.D. levels. Part time graduate program towards M.S. degree available. Apply to Director of Engineering, University of Wisconsin, 600 W. Kilbourn, Milwaukee, Wis.

ASSISTANT OR ASSOCIATE PROFESSOR of Civil Engineering to teach undergraduate and graduate courses in structural engineering. M.S. degree required. Salary for 9 months dependent upon qualifications. If interested, write to John A. Oakey, Civil Engineering Department, North Dakota State College, State College Station, Fargo.

SANITARY AND HYDRAULICS ENGINEERING and Mechanics teaching positions open. Includes summer employment (4/9 of base pay) two out of three summers; good retirement, hospitalization, and life insurance programs. Limited amount of consulting permitted and faculty is encouraged to develop a growing research program. The man to teach in the mechanics fields should be competent to teach theory of elasticity, plates and shells, etc. Large graduate program. Write to Sophus Thompson, Chairman of Civil Engineering, Southern Methodist University, Dallas 5, Texas.

STRUCTURES, HIGHWAY, FLUID Mechanics specialists at Assistant or Associate Professor level. Opportunity to engage in research at Fritz Engineering Laboratory. Also openings as graduate teaching and research assistants and instructors, with opportunity for advanced degrees. Write to Head of Civil Engineering, Lehigh University, Bethlehem, Pennsylvania.

ASSISTANT OR ASSOCIATE PROfessor in Electrical Engineering, rank dependent upon degree held and experience, wanted to teach undergraduate and graduate courses in electrical power and machinery in medium sized engineering college. Send resume of education and experience to C. J. Thomford, Head of Electrical Engineering, University of North Dakota, Grand Forks, N. D.

CIVIL AND MECHANICAL ENGIneering teaching personnel needed in expanding departments of large university. M.S. or Ph.D. required. Openings in all branches at all ranks. Salary and rank will depend upon education and experience. Undergraduate and graduate teaching. Opportunity for research. Location in growing industrial community in central New York. Apply to Dean of Engineering, Syracuse University, Syracuse 10, New York.

ELECTRICAL ENGINEERING STAFF openings beginning September, 1957. Professor or Associate Professor capable of teaching servomechanisms and electrical theory courses. Instructor or Assistant Professor to teach theory and laboratory courses. Electrical Engineering Department, University of Idaho, Moscow, Idaho.

CHEMICAL ENGINEERING FACulty member needed. Rank and salary dependent upon qualifications. Send resume and recent photograph to the Chairman of Chemical Engineering and Chemistry Departments. Fenn College, Cleveland 15, Ohio.

CIVIL ENGINEERING OR ENGIneering Mechanics Associate and Assistant Professors and Instructors needed. M.S. degree desirable, but instructors working toward advanced degree will be considered. Salaries for nine months academic year, paid in ten installments, based upon experience and education. Start September, 1957. Applications for a position as Instructor in Engineering Drawing, Descriptive Geometry, and Surveying will also be considered. Write to Earl D. Dake, South Dakota School of Mines and Technology, Rapid City.

ELECTRICAL AND MECHANICAL Engineering positions open. Teaching assignments are Electric Power, Electronics, Mechanical Vibrations, Fluid Mechanics, and other Mechanical Engineering subjects. Salary depends upon qualifications. Excellent fringe benefits. M.S. in Electrical or Mechanical Engineering desired. Applicants with B.S. considered. Write to Earle M. Morecock, Chairman, Applied Science Division, Rochester Institute of Technology, Rochester, New York.

EIGHT OPENINGS IN FIELDS OF Drawing, Mechanics, and Civil Engineering. Rank and salary commensurate with qualifications. Industrial Arts degrees considered. Start September. Write to Civil Engineering Department, University Idaho, Moscow, Idaho.

NEW MEMBERS OF ASEE

As of March 26, 1957

ANDREWS, ALAN HALL, Instructor in Mechanical Engineering, University of Miami, Coral Gables, Fla. C. E. Anderson, C. P. Marion, Jr.

BANTING, EDWARD ANGUS, Professor of Agricultural Engineering, MacDonald College, Quebec, Canada. C. G. E. Downing, W. Leighton Collins. Divisional Interest: Agricultural Engineering, Mechanical Engineering.

BLEVINS, CRAIN M., Assistant Professor of Drawing Missouri School of Mines and Metallurgy, Rolla. L. C. Christianson, C. L. Wilson.

BURRELL, MONTRUST Q., JR., Instructor in Mechanical Engineering, Prairie View A. & M. College, Prairie View, Tex. F. M. Graham, C. L. Wilson. Divisional Interest: Engineering Drawing, Mechanical Engineering.

COOPER, JAMES HAROLD, Associate Professor of Agricultural Engineering, MacDonald College, Quebec, Canada. C. G. E. Downing, W. L. Collins. Divisional Interest: Agricultural Engineering, Mechanical Engineering.

COX, RONALD M., Executive Vice President, Indianapolis Electronic School, Indianapolis, Ind. L. G. Morey, H. B. Knudsen.

CRENSHAW, CLIFTON W., Assistant Professor of Engineering, Arlington State College, Arlington, Tex. G. E. Smith, J. S. Hopper.

DAVENPORT, MONTY EARL, Instructor in Mechanical Engineering, Texas Technological College, Lubbock. L. J. Powers, D. J. Helmers.

DEMOSS, MERLE L., Head of Engineering Mechanical Section, Department of Engineering Mechanics, General Motors Institute, Flint, Mich. C. E. Stout, H. M. Dent.

DUTCHER, BARRY C., Instructor in Mechanical Engineering, University of Rochester, Rochester, N. Y. T. R. Faucett, C. H. Dawson.

ELLER, CHARLES M., Assistant Professor of Engineering Drawing, Arlington State College, Arlington, Tex. G. E. Smith, J. S. Hopper.

ELLIOTT, BROTHER JAMES, Instructor in Electrical Engineering, Manhattan College, New York, N. Y. R. T. Weil, Jr., Brother A. Leo.

FERGUSON, EARL JOHN, Assistant Professor of Industrial Engineering, Oklahoma A. & M. College, Stillwater. C. R. Draper, W. J. Bentley. Divisional Interest: Engineering Economy, Industrial Engineering, Administrator, Industrial.

FLEMING, PAUL, JR., Instructor in Electrical Engineering, University of Arkansas, Fayetteville. Bryan Webb, Jr., W. W. Cannon.

FRISTOE, HAROLD T., Professor of Electrical Engineering, Oklahoma A. & M. College, Stillwater. T. B. Thompson, C. A. Dunn.

GALBRAITH, E. P., Manager, Technical Personnel Placement, Hanford Atomic Products Operation, General Electric Company, Richland, Wash. T. G. Marshall, H. C. Mayer, Jr.

GOTTSCHALK, WALTER HELBIG, Professor and Chairman of Mathematics Department, University of Pennsylvania, Philadelphia. C. C. Chambers, S. R. Warren, Jr.

GRIFFITH, E. C., Department Head, Mathematics and Science, Long Island Agricultural and Technological Institute, Farmingdale, N. Y. D. W. Allee, R. T. Lincoln.

GROVES, DAVID F., Instructor in Engineering Drawing, West Virginia Institute of Technology, Montgomery. G. C. Slaven, L. C. Nelson.

HAINES, FORREST D., Instructor in Engineering Drawing, Missouri School of Mines and Metallurgy, Rolla. L. C. Christianson, C. L. Wilson.

HALE, JOHN SYMONDS, III, Instructor in Civil Engineering, Bucknell University, Lewisburg, Pa. M. L. Sheridan, D. M. Griffith.

HOLDEN, ROBERT WARREN, Instructor in Mechanical Engineering, New Mexico College of A. & M. A., State College. J. P. Morgan, F. Bromilow. Divisional Interest: Aeronautics, Mechanical Engineering.

JONES, CHARLES DINGEE, Assistant Professor of Mechanical Engineering, The Ohio State University, Columbus. R. H. Zimmerman, W. L. Starkey.

JUVINALL, ROBERT C., Associate Professor of Mechanical Engineering, University of Michigan, Ann Arbor. W. Thomas, R. Evaldson. Divisional Interest: Mechanical Engineering, Mechanics and Materials.

KAHN, CHARLES HOWARD, Assistant Professor of Civil Engineering, North Carolina State College, Raleigh. R. E. Fadum, G. W. Middelton. Divisional Interest: Architecture, Civil Engineering.

KIESLING, ERNST W., Instructor in Civil Engineering, Texas Technological College, Lubbock. D. J. Helmers, G. A. Whetstone.

KINARD, DRAYTON, Professor and Head of Department of Agricultural Engineering, University of Kentucky, Lexington. E. R. Young, E. E. Elsey. Divisional Interest: Agricultural Engineering, Mechanical Engineering.

KOEPSEL, WELLINGTON W., Assistant Professor of Electrical Engineering, Oklahoma A. & M. College, Stillwater. C. F. Cameron, D. D. Lingelbach. Divisional Interest: Electrical Engineering.

KRAUS, WILLIAM ALBERT, Assistant Professor of Petroleum Engineering, Louisiana Polytechnic Institute, Ruston, Louisiana. D. L. Johnson, M. R. Johnson, Jr.

KUMMER, FRED A., Head, Department of Agricultural Engineering, Alabama Polytechnic Institute, Auburn. J. E. Hannum, F. B. Lanham. Divisional Interest: Agricultural Engineering, Mechanical Engineering.

LANGE, KARL O., Professor of Mechanical Engineering, Associate Director of Engineering Experiment Station, University of Kentucky, Lexington. Me.i Baker, M. K. Marshall.

LAWRENCE, JAMES HAROLD, JR., Instructor in Mechanical Engineering, Texas Technological College, Lubbock. D. J. Helmers, L. J. Powers. Divisional Interest: Mechanical Engineering.

LEISSA, ARTHUR WILLIAM, Instructor in Engineering Mechanics, Ohio State University, Columbus. S. B. Folk, C. T. West.

LEWIS, FRANK H., Director of Testing and Guidance Division, Newark College of Engineering, Newark, N. J. F. N. Entwisle, A. P. Johnson.

MADDOX, CYRUS VANCE, Dean of Students, Southern Technical Institute, Chamblee, Ga. G. L. Carroll, A. L. Steinkamp. Divisional Interest: Administrator, Educational, Mathematics.

MONSON, OLOF WILFORD, Professor and Head of Agricultural Engineering Department, Montana State College, Bozeman. E. W. Schilling, E. R. Dodge. Divisional Interest: Agricultural Engineering, Shop and Mechanic Arts.

OLSEN, THEODORE GUY, Assistant Professor of Mechanical Engineering, University of Miami, Coral Gables, Fla. C. E. Anderson, J. H. Clouse.

PEASLEE, W. DHU AINE, President of Valparaiso Technical Institute, Valparaiso, Ind. L. G. Morey, H. B. Knudsen.

PIERCE, JAMES E., Chairman of Mathematics and Enginering Department, Modesto Junior College, Modesto, Calif. R. W. Waymack, H. J. Osner.

POWELL, GEORGE L., Assistant Chief Engineer, Producing Department, Standard Oil Company of California, Western Operations, Inc., Berkeley. E. D. Howe, H. A. Johnson.

RABBY, JOHN W., Instructor in English, Marquette University, Milwaukee, Wis. D. E. Schiller, A. C. Moeller.

RAKER, PAUL H., Head of Mathematics Section, General Motors Institute, Flint, Mich. C. E. Stout, C. A. Brown.

RIGHTS, ROBERT M., Instructor in Engineering Drawing, Newark College of Engineering, Newark, N. J. R. G. Salamon, F. J. Burns.

RUMER, RALPH R., JR., Assistant Instructor in Civil Engineering, Rutgers University, New Brunswick, N. J. W. B. Snow, A. J. DelMastro.

SAEMANN, JESSE C., JR., Assistant Professor of Mechanics, University of Wisconsin, Madison. G. W. Washa, G. Pickett. Divisional Interest: Civil Engineering, Mechanics and Materials.

SCHMIDT, EMIL S., JR., Assistant Professor of Chemical Engineering, Lafayette College, Easton, Pa. W. G. McLean, Z. D. Jastrzebski.

SWINSON, WELDON F., Instructor in Mechanical Engineering, Texas Technological College, Lubbock. D. J. Helmers, L. J. Powers.

WEBER, ROBERT L., Associate Professor of Physics, Pennsylvania State University, University Park. Wayne Webb, J. A. Sauer.

WILLIAMS, IRA L., Professor and Head of Agricultural Engineering, Texas Technological College, Lubbock. L. J. Powers, D. J. Helmers. Divisional Interest: Agricultural Engineering.

WOODRING, RICHARD E., Instructor in Civil Engineering, Drexel Institute of Technology, Philadelphia, Pa. L. P. Mains, R. V. Giles.

As of April 16, 1957

ABRAMS, JOHN P., Associate Professor of Civil Engineering, University of Pittsburgh, Pittsburgh, Pa. R. Bonn, W. L. Grecco.

ARKILIC, GALIP MEHMET, Assistant Professor of Engineering Mechanics, Pennsylvania State University, University Park. J. Marin, J. W. Breneman.

AVALLONE, EUGENE A., Assistant Professor of Mechanical Engineering, City College of New York, New York, N. Y. A. F. Baldo, G. J. Bischof. Divisional Interest: Mechanical Engineering, Mechanics and Materials.

BEER, FERDINAND P., Professor of Mechanics, Lehigh University, Bethlehem, Pa. L. V. Bewley, J. C. Osborn.

BEISTLINE, EARL H., Dean, School of Mines, University of Alaska, College. W. S. Wilson, E. F. Rice. Divisional Interest: Administrator, Educational, Geol., Metall., Min.

BELEAL, ARTHUR P., Instructor in Engineering, El Camino College, El Camino, Calif. W. J. De Spain, W. H. Smith. Divisional Interest: Engineering Drawing, Mathematics.

BENUMOF, REUBEN, Head, Mathematics-Science Department, Staten Island Community College, New York, N. Y. W. L. Willig, I. L. Kosow. Divisional Interest: Mathematics-Science, Physics.

BERNHARDT, LEE F., Director, Engineering Drawing Department, Indiana Technical College, Fort Wayne. I. A. Planck, R. C. Ruhl. Divisional Interest: Engineering Drawing, Mechanical Engineering.

BERRY, RALPH M., Professor of Geodesy and Surveying, Civil Engineering Department, University of Michigan, Ann Arbor. H. J. McFarlan, D. N. Cortright.

BROWN, WILLIAM E., Instructor in Engineering Drawing, University of Tennessee, Knoxville. C. A. Newton, A. B. Wood. Divisional Interest: Engineering Drawing, English.

BRYAN, BILLY B., Associate Professor of Agricultural Engineering, University of Arkansas, Fayetteville. Xzin McNeal, G. F. Branigan.

FIELD, JAMES W., Assistant Professor of Mechanical Engineering, New Mexico College of A. & M., State College. J. P. Morgan, M. A. Thomas. Divisional Interest: Mechanical Engineering, Shop and Mechanic Arts.

FRENCH, JAMES L., Instructor in Mechanical Engineering, University of Tennessee, Knoxville. W. K. Stair, J. M. Tucker. Divisional Interest: Mathematics, Mechanical Engineering.

HALLOCK, JOHN I., Instructor in Engineering, San Francisco City College, San Francisco, Calif. J. F. Schon, A. E. Edstrom. Divisional Interest: Engineering Drawing, Shop and Mechanic Arts.

HAMAN, ARTHUR C., Instructor in Mechanical Engineering, University of Detroit, Detroit, Mich. H. Gudebski, L. S. Kowalczyk.

HARDY, F. RAYMOND, Instructor in Engineering, Lowell Technological Institute, Lowell, Mass. J. A. Irvine, H. E. Thomas.

HEAGLER, JOHN B., JR., Assistant Professor of Civil Engineering, Missouri School of Mines, Rolla. C. L. Wilson, E. W. Carlton.

HOEHN, ROBERT G., Assistant Professor of Mathematics and Civil Engineering, Indiana Technical College, Fort Wayne. R. C. Ruhl, I. A. Planck.

LUNDY, TED S., Instructor in Engineering Drawing, University of Tennessee, Knoxville. A. B. Wood, G. H. Parham, Jr. Divisional Interest: Engineering Drawing, Metallurgy.

MARSHALL, ROBERT R., Assistant Professor of Mechanical Engineering, Indiana Technical College, Fort Wayne. I. A. Planck, R. C. Ruhl. Divisional Interest: General Engineering, Mechanical Engineering.

MATILLA, AURELIO, Professor of Civil Engineering, College of Agriculture and Mechanic Arts, Mayaguez, P. R. F. Gonzalez-Mandry, H. Marti-Marini.

MCHUGH, RICHARD J., Instructor in Mechanical Engineering, University of Detroit, Detroit, Mich. W. Felbarth, R. W. Ahlquist. Divisional Interest: Mechanical Engineering, Mechanics and Materials.

MCMASTER, ROBERT K., Instructor in Engineering Drawing, University of Tennessee, Knoxville. C. A. Newton, A. B. Wood. Divisional Interest: Engineering Drawing.

MCPHERSON, JAMES I., Instructor in Mechanical Engineering, New Mexico College of A. & M. A., College. A. M. Lukens, J. P. Morgan. Divisional Interest: Mechanical Engineering, Mechanics and Materials.

MESSER, SIDNEY, Instructor in Engineering, City College of San Francisco, San Francisco, Calif. W. K. Mayo, C. J. Aggeler.

MIERBNER, HORST, Abteilungsvorstand, Ing.-wiss. Abt., Leverkusen-Bayerwerk, Germany. W. L. Everitt, W. L. Collins.

PETSCAVAGE, MICHAEL J., Instructor, General Extension Department, Pennsylvania State University Center, Wilkes Barre. V. E. Neilly, G. W. Bierly.

PHILBY, ALFRED J., Associate Professor of Engineering Drawing, Ohio State University, Columbus. C. J. Vierck, C. H. Kearns.

QUINN, CLEO J., Instructor in Mechanical Engineering, Indiana Technical College, Fort Wayne. I. A. Planck, R. B. Miller. Divisional Interest: Mechanical Engineering.

RICH, LINVIL G., Associate Professor of Civil Engineering, Illinois Institute of Technology, Chicago. E. I. Fiesenheiser, E. Vey.

ROTHERMEL, U. AMEL, Lecturer in Mechanical Engineering, City College of New York, New York. S. J. Tracy, G. A. Guerdan. Divisional Interest: Mechanical Engineering.

SALVATORE, JOSEPH, Research Assistant, Control Systems Laboratory, University of Illinois, Urbana. E. C. McClintock, Jr., W. L. Collins.

SCHENKEL, ROY W., Instructor in Mathematics, Lawrence Institute of Technology, Detroit, Mich. H. W. Nace, G. P. Brewington. Divisional Interest: Electrical Engineering, Mathematics.

SCHUTZWOHL, VICTOR U., Instructor in Electrical Engineering, University of Detroit, Detroit, Mich. H. Gudebski, L. S. Kowalczyk.

SELTZER, NORMAN, Industrial Relation Research Analyst, Training Depart-

ment, Ford Motor Company, Dearborn, Mich. A. W. Angrist, R. W. Cain.

SIMAS, CARLOS FURTADO DE, Director of Civil Engineering, Escola Politecnica, University of Bahia, Salvador-Bahia-Brazil. W. L. Everitt, W. L. Collins. Divisional Interest: Administrator, Educational; Civil Engineering.

SMITH, JAMES L., Instructor in Civil Engineering, Bradley University, Peoria, Ill. M. G. Abegg, H. Blickensderfer.

SNYDER, ROBERT D., Instructor in Mechanical Engineering, Indiana Technical College, Fort Wayne. R. B. Miller, I. A. Planck. Divisional Interest: Mathematics, Mechanical Engineering, Mechanics and Materials.

STARK, ROBERT M., Assistant Dean of Engineering, Fenn College, Cleveland 15, Ohio. M. Ellingson, L. F. Smith.

TARBUTTON, JAMES S., Assistant Professor of Electrical Engineering, Louisiana Polytechnic Institute, Ruston. A. C. Thigpen, R. Wynn.

TEAGUE, JOSEPH G., Instructor in Mechanical Engineering, University of Kentucky, Lexington. M. Baker, M. K. Marshall.

TREFNY, RICHARD B., Director of Aeronautical Engineering, Parks College of St. Louis University, East St. Louis, Ill. J. C. Choppesky, V. J. Blum. Divisional Interest: Administrator, Educational; Aeronautics and Aero. Engr.

WATT, JOHN R., Associate Professor of Mechanical Engineering, University of Texas, Austin. M. L. Begeman, B. H. Amstead. Divisional Interest: Architectural Engineering, Engineering Economy, Economics, History, Psychology, Mechanical Engineering, Refrigeration and Air Conditioning.

WEBB, EDGAR G., Assistant Professor of Agricultural Engineering, Ontario Agricultural College, Guelph, Ontario, Canada. C. G. E. Downing, W. L. Collins. Divisional Interest: Aeronautics and Aero. Engr., Agricultural Engineering.

WHIPPLE, WALTER G., Technician Recruitment, Educational Department, Westinghouse Electric Corporation, Pittsburgh, Pa. G. D. Lobingier, C. E. Ebert, Jr.

WHITTED, HUGH E., JR., Assistant Superintendent, Engineering Training Department, Western Electric Co., Inc., Winston-Salem, N. C. E. J. Thieien, F. R. Michael.

WILLIAMS, DONALD D., Instructor in General Engineering, Tennessee Polytechnic Institute, Cookeville. J. S. Brown, D. W. Mattson.

WOODFIELD, KENNETH W., Faculty Member, Science Department, General Motors Institute, Flint, Mich. L. B. Wocholski, J. M. Biedenbach. Divisional Interest: Mechanical Engineering and Physics.

XIQUES, RICHARD J., Instructor in Engineering Drawing, University of Tennessee, Knoxville, Tenn. A. B. Wood, G. H. Parham, Jr. Divisional Interest: Civil Engineering, Engineering Drawing.

YANTIS, CHARLES W., Associate Professor of Engineering Mechanics, University of Arkansas, Fayetteville, Ark. L. R. Heiple, J. R. Bissett.

As of May 10

AFFLERBACH, HARRY R., Metallurgist, United States Steel Corporation, Central Operations, Fairless Hills, Pa. S. J. Hirschfield, J. Perdue.

ANDRES, ANTHONY J., Assistant Professor of Engineering, Los Angeles State College, Los Angeles, Calif. H. Storch, L. Cromwell.

BAKER, ROBERT C., Instructor in Engineering, Pennsylvania State University, University Park. F. B. Moore, W. L. Richard.

BEAUCHAMP, CLARENCE J., Instructor in Descriptive Geometry and Drafting, Chrysler Institute, Detroit, Mich. R. L. Hart, K. J. Farquharson.

BEESTON, JOSEPH M., Assistant Professor of Metallurgy, Washington State College, Pullman. G. H. Dunstan, L. L. Francis.

BURNS, WILLIAM A., Manager, Personnel Division, Hanford Atomic Products Operation, General Electric Company, Richland, Wash. R. E. Curtis, D. S. Roberts. Divisional Interest: Administrator Ind. Chem. E.

BURROUGHS, ROBERT E., Assistant Director, Engineering Research Institute, University of Michigan, Ann Arbor. R. G. Folsom, G. G. Brown.

BYRNE, JOHN E., Vice President and General Manager, California Air College, Division of Central Technical Institute, Kansas City, Mo. C. L. Foster, N. E. Vilander.

CAIN, JOHN L., Director, Cooperative Progress, Virginia Polytechnic Institute, Blacksburg. D. C. Hunt, S. J. Hirschfield.

CALVERT, FLOYD O., Instructor in Mechanical Engineering, University of Oklahoma, Norman. E. F. Dawson, E. M. Sims. Divisional Interest: M. E.

CARLTON, LEMUAL D., Dean of Admissions, Embry-Riddle Aeronautical Institute, Miami, Fla. H. W. Hartley, W. M. Hartung. Divisional Interest: Administrator Educ., Tech. Inst.

CARSON, RALPH S., Chairman, Electronic Engineering, Indiana Technical College, Fort Wayne. R. C. Ruhl, C. A. Overholt. Divisional Interest: E. E., Math.

CHU, KUANG-HAN, Associate Professor of Civil Engineering, Illinois Institute of Technology, Chicago. E. I. Fiesenheiser, E. Vey.

COCHRAN, JOHN R., Instructor in Chemical Engineering, Indiana Technical College, Fort Wayne. R. C. Ruhl, T. G. Dixon. Divisional Interest: Chem. E., Tech. Inst.

CRANMER, JOSEPH W., Assistant Professor of Chemical Engineering, Indiana Technical College, Fort Wayne. R. C. Ruhl, T. G. Dixon. Divisional Interest: Chem. E., Chem.

DARLINGTON, ROBERT P., Assistant Professor of Architectural Engineering, Washington State College, Pullman. E. G. Ericson, L. B. Almy.

DE FOTIS, WILLIAM, Instructor in General Engineering, University of Illinois, Chicago Undergraduate Division, Chicago. M. V. J. Dembski, C. I. Carlson.

DONAHUE, WILLIAM E., Chairman, Chemistry Department, Indiana Technical College, Fort Wayne. R. C. Ruhl, T. G. Dixon. Divisional Interest: Chem.

ETTER, LEONARD R., Assistant Professor of Physics, Indiana Technical College, Fort Wayne. I. A. Planck, R. C. Ruhl. Divisional Interest: Math., Physics.

FITZPATRICK, JAMES L. G., Head, Mechanical Technology, State Island Community College, Staten Island, N. Y. H. L. Willig, I. L. Kosow. Divisional Interest: Mech. Tech., G. E.

HEAD, DR. J. W., President, Electronics Institute, Incorporated, Detroit, Mich. D. C. Hunt, S. J. Hirschfield.

JONES, ALDEN M., Specialist in Engineering Education, Heavy Military Electronic Equipment Department, General Electric Company, Syracuse, N. Y. J. B. Russell, C. F. Spitzer. Divisional Interest: Administrator Ind., Eng. Educ.

JONSSON, JENS J., Chairman, Electrical Engineering Department, Brigham Young University, Provo, Utah. D. J. Monson, L. K. Baxter.

KAUFMANN, MORRIS I., Assistant Professor of Engineering, Idaho State College, Pocatello. A. S. Janssen, A. L. Lillibridge.

KEAR, EDWARD B., JR., Instructor in Mechanical Engineering, Clarkson College of Technology, Potsdam, N. Y. R. D. Larsson, M. G. Mochel. Divisional Interest: M. E.

KHAMMASH, TARIG B., Instructor in Engineering Mechanics, University of Michigan, Ann Arbor. R. D. Yagle, R. A. Dodge.

KING, RAY J., Instructor in Electronic Engineering, Indiana Technical College, Fort Wayne. R. C. Ruhl, C. A. Overholt. Divisional Interest: E. E., G. E.

KORDA, EDWARD J., Associate Professor of Metallurgical Engineering, Drexel Institute of Technology, Philadelphia, Pa. A. W. Grosvenor, J. B. Baker.

MACKLIN, HOWARD A., Associate Professor of Mechanics, Indiana Technical College, Fort Wayne. I. A. Planck, R. C. Ruhl. Divisional Interest: G. E., M. E.

MARTIN, ALBERT R., Instructor in Electronics, Indiana Technical College, Fort Wayne. R. C. Ruhl, C. A. Overholt. Divisional Interest: E. E., Math.

MILLER, KENNETH R., President, Ohio Mechanics Institute, Cincinnati. P. K. Johnston, C. S. MacFarlane.

MORGAN, JOHN P., Associate Professor of Mining Engineering, University of Adelaide, Adelaide, South Australia. G. S. Brown, C. E. Tucker.

O'CONNOR, REV. JOHN S., Chairman and Coordinator of Physics, St. Joseph's College, Philadelphia, Pa. C. A. Kopp, J. W. Neal, Jr.

PABARCINS, ALGIS, Instructor in Civil Engineering, University of Illinois, Chicago. M. V. J. Dembski, E. H. Coe.

POWERS, NORMAN R., Instructor in Mechanics and Design, University of Buffalo, Buffalo, N. Y. K. B. O'Callahan, G. N. Praemassing.

PRATT, JOHN M., Head, Cultural Studies, General Motors Institute, Flint, Mich. C. A. Brown, H. M. Dent. Divisional Interest: English, Human.-S. S.

PRICE, ARTHUR B., Assistant Professor of Electronics, Indiana Technical College, Fort Wayne. R. C. Ruhl, C. A. Overholt. Divisional Interest: E. E., Phys.

ROSE, FRANK E., Teacher, Department of Electronics, General Motors Institute, Flint, Mich. J. M. Biedenbach, L. B. Wocholski. Divisional Interest: E. E., Physics.

SIMON, ERNEST J., Dean, Technical and Adult Education, Southern Illinois University, Carbondale. M. K. Humble, W. L. Collins. Divisional Interest: Administrator Educ., Tech. Educ., Tech. Inst.

SLATER, LLOYD E., Executive Director, Foundation for Instrumentation Education, Ridgefield, Conn. R. J. Jeffries, G. S. Timoshenko. Divisional Interest: G. E., Tech. Inst.

STEPHENSON, KERMIT Q., Instructor in Agricultural Engineering, University of Arkansas, Fayetteville. X. McNeal, B. B. Bryan. Divisional Interest: Agr. E., E. E.

THEAKSTON, FRANKLYN H., Professor of Civil Engineering, Ontario Agricultural College, Guelph, Ontario, Canada. C. G. E. Downing, W. L. Collins.

TRUXAL, JOHN G., Head, Electrical Engineering, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. C. C. Whipple, J. W Hostetter. Divisional Interest: Administrator Educ., E. E.

WESTERHEIDE, JOHN R., Director, Research Center, University of Dayton, Dayton, Ohio. K. S. Schraut, A. J. Holian.

WHITE, NORMAN E., Associate Professor of Chemistry, Drexel Institute of Technology, Philadelphia, Pa. R. S. Hanson, M. R. Wehr. Divisional Interest: Chem.

WHITNEY, JOHN A., Assistant Professor of Electrical Engineering, Indiana Technical College, Fort Wayne, Indiana. R. C. Ruhl, C. A. Overholt. Divisional Interest: E. E., Physics.

WIESINGER, FREDERICK P., Lecturer, Engineering Mechanics, University of Illinois, Chicago. M. V. J. Dembski, E. H. Coe.

WILLIAMS, ROBERT M., Director, Engineering Design Division, Embry-Rid-

dle Aeronautical Institute, Miami, Fla. H. W. Hartley, W. M. Hartung. Divisional Interest: Administrator Educ., Aeron. Electronics, Aeron. and Aero. E., Tech. Inst.

YOUNG, RALPH W., Head, Math.-Physics Departments, Indiana Technical College, Fort Wayne. I. A. Planck, R. C. Ruhl. Divisional Interest: Math.

ZIMPFER, WALTER H., Associate Professor of Civil Engineering, University of Florida, Gainesville. J. E. Kiker, Jr., W. A. Nash.

50 new members
735 previously added

785 new members this year

AEC PRICE LIST

A new free price list of Atomic Energy Commission unclassified research reports is available from the Office of Technical Services. This cumulative listing contains 454 items issued since June 30, 1956. To obtain it, write for AEC Research Reports Price List No. 27 from OTS, U. S. Department of Commerce, Washington 25, D. C. Price lists are issued semi-annually, and the next list will be available in August, 1957.

OTS also publishes *U. S. Government Research Reports,* a monthly publication which describes new research reports as soon as they are released by the AEC, as well as reports from the armed services. This publication can be obtained on a subscription basis from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., at a cost of $6.00 per year.

1957 ECRC RESEARCH REVIEW

The 1957 *Engineering College Research Review* will be available in late July. It will list research organizations and income, active projects, sponsors, areas of interest or concentration, a condensed history of the Engineering College Research Council, and a statement of its research policies. Copies will be obtainable at $2.00 each by writing to Professor Renato Contini, New York University, University Heights, New York 53. The *Review* would be useful both in research offices and in engineering or special libraries.

1957 SUMMER INSTRUCTION

MIT SUMMER SHORT COURSES

Among the short courses offered during the 1957 Summer Session at Massachusetts Institute of Technology will be the following:

June 11–12 Soil Engineering in Frost Areas
June 17–28 Internal Combustion Engines
June 17–28 Modern Developments in Combustion
June 17–28 Organization
June 17–28 Stress Analysis
June 17–28 Wear Theory
June 24–July 5 Nuclear Reactor Technology
June 24–July 6 Missile Aerodynamics
July 1–12 Thermodynamics
July 1–12 Turbomachinery
July 8–12 Physical Chemistry of Flotation
July 8–12 Psychology of Man-Machine Systems
July 8–19 Principles of Radioisotope Utilization
July 15–19 Strain Gage Techniques
July 15–26 Photogrammetric Engineering
August 12–16 Analog-Digital Conversion Techniques

Additional information can be obtained by writing to the Office of the Summer Session, Room 7–103, M.I.T., Cambridge 39.

CREATIVE PROBLEM-SOLVING INSTITUTE

The University of Buffalo, in collaboration with the Creative Education Foundation, will present the Third Annual Creative Problem-Solving Institute, July 8–10. The objectives of the meeting are to provide knowledge of educational methods for the development of personal creativity, training in the operational use of creative procedures for organizational problem-solving, and to help participants conduct creative problem-solving courses and programs, as well as organize and lead "brainstorming" sessions.

In addition, participants will have opportunities to discuss their own problems and interests with experienced leaders and to select specialized seminars in terms of personal interests. For further information write to Dr. Sidney J. Parnes, Director of Creative Education, The University of Buffalo, Buffalo 14, New York.

BROOKLYN POLYTECHNIC SUMMER LAB

To meet the demands of scientists, especially from industry, for advanced professional instruction in the use of specialized physical tools in chemistry and physics, the Polytechnic Institute of Brooklyn will sponsor a new summer "Laboratory Program for Industry" from June 3 to August 12.

Intensive one and two-week courses in X-Ray Diffraction, Infrared Spectroscopy, New Electrolytic Techniques, New Polymerization Techniques and Stereospecific Polymers, and Ion Exchange Resins and Membranes will be offered. Also featured will be a series of general evening lectures in Polymer Chemistry to meet the needs of scientists who do not wish to enroll in the laboratory portion of the courses.

Inquiries should be sent to Mrs. Doris Cattell, Summer Laboratory Program, Polytechnic Institute of Brooklyn, 99 Livingston Street.

NUCLEAR ENGINEERING SUMMER COURSES

University of California, Berkeley

July 1–August 30: Short course for engineers who need basic knowledge and facility in nuclear engineering.

July 8–12: Nuclear Engineering Survey, one week of lectures, demonstrations, and discussions, for those who must plan and administer nuclear energy programs.

For further information write to Engineering and Science Extension, Nuclear Energy Programs, Room 100, Building T-11, University of California, Berkeley 4.

University of Michigan, Ann Arbor

August 19–30: Nuclear Reactors and Radiations in Industry, an intensive course for practicing engineers without previous experience in nuclear technology who wish to acquire a knowledge of representative problems and techniques in this field.

Direct all correspondence to Professor William Kerr, Phoenix Memorial Laboratory, University of Michigan, Ann Arbor.

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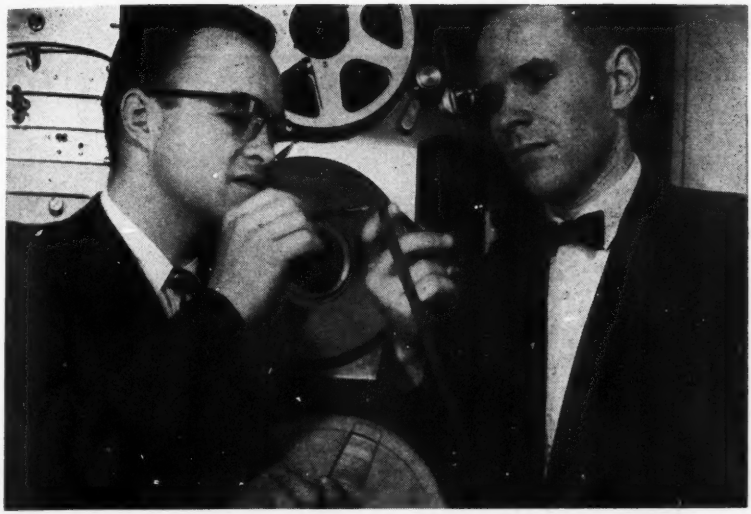
SECTION MEETINGS

Section	*Location of Meeting*	*Dates*	*Chairman of Section*
Allegheny	Pennsylvania State University	April 26–27, 1957	B. A. Whisler, Pennsylvania State University
Illinois-Indiana	Northwestern University	May 18, 1957	O. W. Eshbach, Northwestern University
Kansas-Nebraska	Kansas State College	Oct. 25–26, 1957	K. Razak, University of Wichita
Michigan	General Motors Institute	May 4, 1957	C. L. Fanning, General Motors Institute
Middle Atlantic	McGraw-Hill Book Co., New York City	Dec. 7, 1957	W. G. McLean, Lafayette College
Missouri-Arkansas	University of Arkansas	April 6, 1957	L. R. Heiple, University of Arkansas
National Capital Area	National Science Foundation	Oct. 2, 1956	W. J. Huff, University of Maryland
New England	University of Massachusetts	Oct. 12, 1957	W. S. Evans, University of Maine
North Midwest	Minneapolis, Minn.	Oct., 1957	P. Cartwright, University of Minnesota
Ohio	Ohio State University	April, 1958	M. L. Smith, Ohio State University
Pacific Northwest	Washington State College	May 9–10, 1957	M. C. Jenson, Washington State College
Pacific Southwest	U. S. Naval Post-graduate School, Monterey, Calif.	Dec. 27–28, 1957	I. J. Sandorf, University of Nevada
Rocky Mountain	Brigham Young University	April 27, 1957	B. Brown, Brigham Young University
Southeastern	Brown Hotel Louisville, Ky.	April 4–5, 1957	M. Baker, University of Kentucky
Southwest	Texas A. & M. College	April 18–19, 1957	E. M. Thomas, Texas Western College
Upper New York-Ontario	University of Rochester	Oct., 1957	T. R. Faucett, University of Rochester

Members of the Society are welcome at all Section Meetings

ASEE CALENDAR OF EVENTS

Meeting	*Date*	*Location*	*Chairman or Information*
ASEE ANNUAL MEETING	JUNE 17–21	CORNELL UNIVERSITY	J. C. Gebhard
Fourth National Surveying Teachers Conference	August 4–9	Camp Welch, Naches, Wash.	E. G. Ericson, Washington State College
New England Section	October 12	University of Massachusetts	W. S. Evans, U. of Maine
Kansas-Nebraska Section	October 25–26	Kansas State College	K. Razak, University of Wichita
North Midwest Section	October	Minneapolis, Minnesota	P. Cartwright, University of Minnesota
Upper New York-Ontario Section	October	University of Rochester	T. R. Faucett, University of Rochester
Middle Atlantic Section	Dec. 7	McGraw-Hill Co. New York City	W. G. McLean, Lafayette College
Pacific Southwest Section	December 27–28	U. S. Naval Post-graduate School, Monterey, Calif.	I. J. Sandorf, University of Nevada
1958			
Midwinter Drawing Meeting	Jan. 15–17	Flint, Mich.	Earl D. Block, General Motors Institute
Ohio Section	April	Ohio State University	M. L. Smith, Ohio State U.
ASEE ANNUAL MEETING	June 16–20	University of California, Berkeley	E. D. Howe



Bell Laboratories researchers Henry S. McDonald, Dr. Eng. from Johns Hopkins, and Max V. Mathews, Sc.D. from M.I.T., examine magnetic tape used in new research technique. Voice waves are converted into sequences of numbers by periodic sampling of amplitudes, 8000 samples per second. General purpose electronic computers act on these numbers as a proposed transmitting device might.

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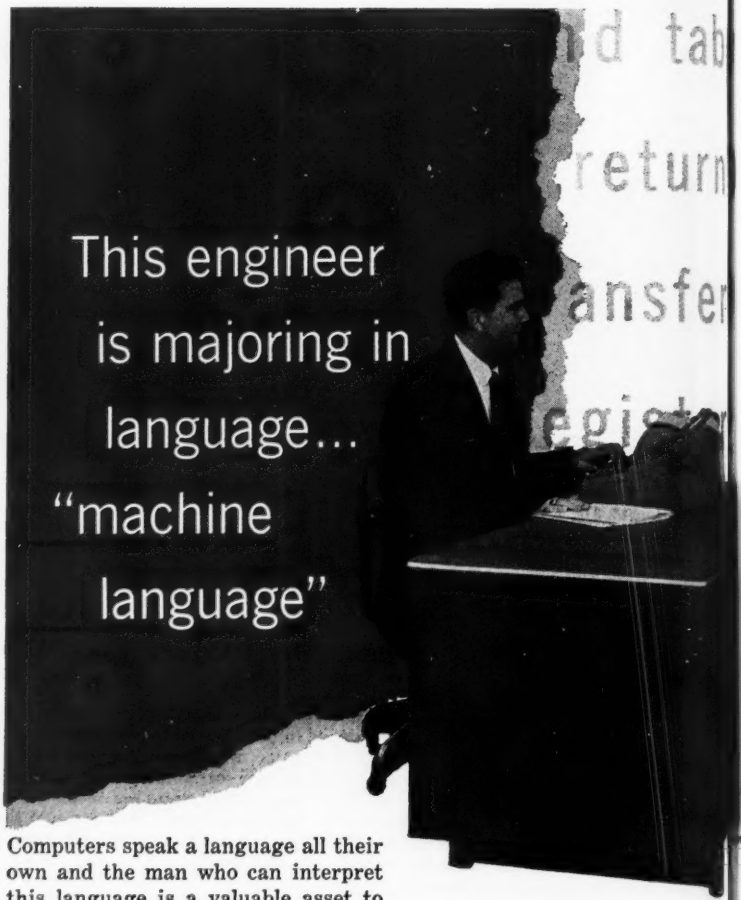

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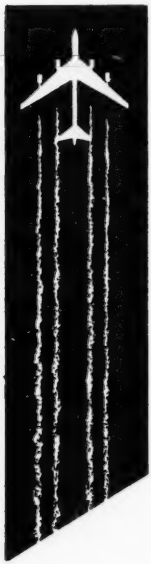

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